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Project Retrosight

Understanding the returns from cardiovascular and stroke research



Cover Design 'Pieces of Impact':

Each piece of the jigsaw draws inspiration from one of the research grants in the study; the thirtieth piece from the three-country collaboration.

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Project Retrosight

Understanding the returns from
cardiovascular and stroke research

THE POLICY REPORT

**Steven Wooding, Stephen Hanney, Alexandra Pollitt,
Martin Buxton and Jonathan Grant
on behalf of the Project Retrosight Team**

Preface

This report¹ describes a case study-based review of 29 cardiovascular and stroke research grants, funded in three countries between 1989 and 1993. The case studies focused on the individual grants but considered the development of the investigators and ideas involved in the research projects from initiation to the present day. Basic biomedical and clinical cardiovascular and stroke research grants awarded in Australia, Canada and the UK were selected through a stratified random selection approach that aimed to include both high- and low-impact grants. The structured case studies were used to assess the impact of these grants in detail and to draw conclusions about the relationship between impact and a range of factors. The key messages are as follows.

- The cases reveal that a large and diverse range of impacts arose from the 29 grants studied.
- There are variations between the impacts derived from basic biomedical and clinical research.
- There is no correlation between knowledge production and wider impacts.
- The majority of economic impacts identified come from a minority of projects.
- We identified factors that appear to be associated with high and low impact.

This report presents the key observations of the study and an overview of the methods involved. It has been written for funders of biomedical and health research and health services, health researchers, and policy makers in those fields. It will also be of interest to those involved in research and impact evaluation. The accompanying

Methodology Report² presents the methods used in more detail and the Case Study Report³ presents all 29 case studies that were carried out.

This work was led by RAND Europe in collaboration with the Health Economics Research Group (HERG) at Brunel University. RAND Europe is an independent not-for-profit policy research organisation that serves the public interest by improving policy making and informing public debate. The Health Economics Research Group is a Specialist Research Institute of Brunel University dedicated to conducting accessible, policy-relevant research of a high academic quality that is focused on improving the efficiency and cost-effectiveness of resources devoted to health care and to research. This report has been peer-reviewed in accordance with RAND's quality assurance standards⁴ and therefore may be represented as a RAND Europe product.

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¹ This study was supported by an international collaboration of research funders. Please see the Acknowledgements, page xiii, for details.

² Pollitt, A., S. Wooding, S. Hanney, M. Buxton and J. Grant. *Project Retrosight. Understanding the returns from cardiovascular and stroke research: Methodology Report*. Cambridge, UK: RAND Europe, TR-925-RS, 2011.

³ Pollitt, A., S. Wooding, S. Hanney, M. Buxton and J. Grant. *Project Retrosight. Understanding the returns from cardiovascular and stroke research: Case Studies*. Cambridge, UK: RAND Europe, TR-926-RS, 2011.

⁴ RAND Europe: see <http://www.rand.org/about/standards/> [Accessed 16 December 2010]

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Executive summary

All funders have more opportunities for investment in research than they can support, many of which relate to areas of science of high potential interest and/or impact. How best to choose between these is a key issue for funders, the scientific community, governments and society. The “science of science” is a growing field that aims to understand what works in research funding.⁵ This requires a better understanding of research performance, and more importantly the drivers of improved performance. At a conceptual level we need to understand what factors lead to research impact. For example, what kinds of science, what kinds of scientists, and what settings are most conducive to ensuring the scientific success of research and its translation into societal benefits?

Project Retrosight

Project Retrosight was a multinational study that investigated the translation of, and payback from, basic biomedical and clinical cardiovascular and stroke research projects. The main project aims were to:

- examine the variety of payback produced by basic biomedical and clinical cardiovascular and stroke research;
- identify factors associated with high (and low) levels of payback, in particular factors relating to the characteristics of the research, how it was supported or the context in which it was carried out.

⁵ Marburger, J.H. “Wanted: better benchmarks.” *Science* 308 (2005): 1087. Grant, J., and S. Wooding. *In search of the Holy Grail: understanding research success*. Cambridge, UK: RAND Europe, OP-295-GBF, 2010.

The name Project Retrosight is derived from two landmark studies in science policy. The first – Project Hindsight (1967) – was a study sponsored by US Department of Defense that examined the incremental advances of various technologies.⁶ The second was Julius Comroe’s book, *Retrospectroscope: Insights into Medical Discovery* (1977).⁷ Comroe examined new life-saving advances in medicine and how they had come about. At the same time, in a more or less direct response to Project Hindsight, he worked with Robert Dripps to trace the research antecedents of clinical advances in cardiovascular medicine. This study was described in an article in *Science*.⁸ The idea of Project Retrosight was to develop these ideas by tracing prospectively, with the benefit of hindsight, the payback and translation of funded research projects.

Project Retrosight builds on successful methodologies used to evaluate diabetes and arthritis research funding.⁹

Our approach involved identifying the principal investigators (PIs) of all grants awarded in the early 1990s for basic biomedical and clinical cardiovascular and stroke research by specific funders in Australia, Canada and the United Kingdom. These PIs were sent simple questionnaires that were used to estimate the impact of the work funded by the grant. A random sample of grants was then selected

⁶ Sherwin, C.W. and R.S. Isenson. “Project Hindsight. A Defense Department study on the utility of research.” *Science* 161 (1967): 1571–7.

⁷ Comroe, J.H. *Retrospectroscope: insights into medical discovery*. Menlo Park, California: Von Gehr Press, 1977.

⁸ Comroe, J.H. and R.D. Dripps. “Scientific basis for the support of biomedical science.” *Science*, 192 (1976): 105–11

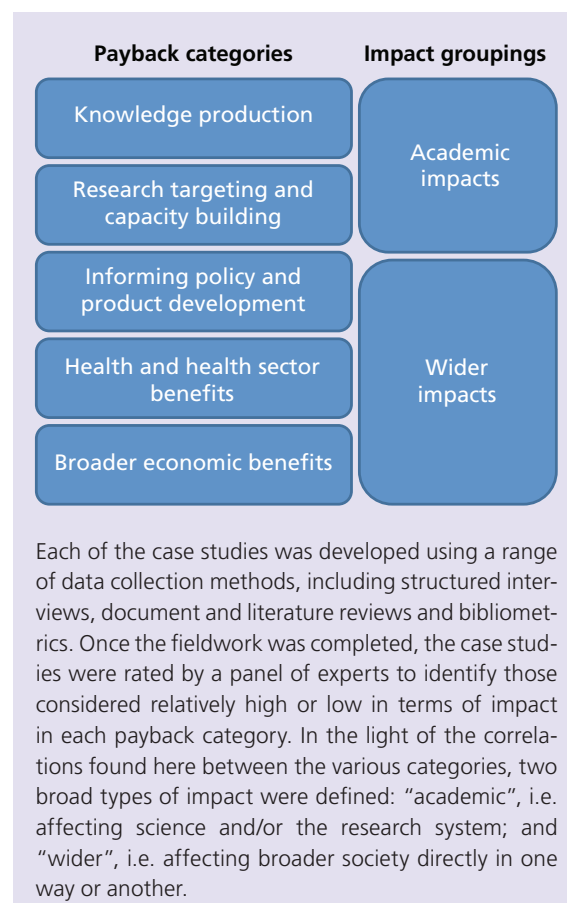
⁹ Hanney, S., P. Home, I. Frame, J. Grant, P. Green and M. Buxton. “Identifying the impact of diabetes research.” *Diabetic Medicine* 23 (2006): 176–84. Wooding, S., S. Hanney, M. Buxton and J. Grant. “Payback arising from research funding: Evaluation of the Arthritis Research Campaign.” *Rheumatology* 44 (2005): 1145–56.

using a sampling framework stratified according to location of research (Canada, Australia and UK), type of research (basic biomedical or clinical), size of research grant (large or small) and perception of impact by the PI (high or low). Detailed case studies were then developed for 29 grants (in total we approached 38 cases: 6 PIs declined to participate, 3 case studies were not completed/not included for other reasons). We chose a case study approach since, in general, case studies provide a rich source of material when “how” or “why” questions are proposed.¹⁰ In the context of Project Retrosight, the case studies provide a detailed picture of what led to establishing the grant, how the research progressed and how it subsequently developed.

A number of approaches have been developed to describe and capture the impacts of research.¹¹ We used the Payback Framework,¹² which has two elements: five payback categories, which we collapsed into two impact groups for some of our analysis (summarised in Figure S.1); and the payback model (illustrated in Figure 1.2, Chapter 1). The Payback Framework provides a common structure for examining why the PI applied for the research grant and what he or she hoped to achieve with the funding; the responses of the funding committees; the research process, including collaborations, use of shared resources, etc.; research outputs (e.g. publications); how those outputs influenced subsequent research topics and careers; how the research was subsequently translated into “secondary outputs”, through influencing clinical policies or product development; and how the research then translated into improvements in health and broader economic benefits.

Examples of academic impacts included publication of papers, supervising a PhD, developing scientific methods subsequently used by other researchers, etc. Examples of wider impacts included citation in policy documents or guidelines, licensing intellectual property, briefing senior

Figure S.1
Payback categories and impact groups



policy makers, changes in policy or practice, etc. The case studies were then coded qualitatively and analysed to identify factors that appeared to be associated with high and low impact in both academic and wider categories. The associations that emerged were then tested and refined in discussion with researchers, funders and policy makers, and developed into a series of policy implications for research funders.

There are, of course, a number of limitations to the analysis. The number of case studies used in Project Retrosight can be viewed as both a limitation and a strength. Whilst the number of case studies is greater than in most other studies of a similar nature¹³, the sample size may still not be

¹⁰ Yin, R.K. *Case study research: design and methods* (3rd ed.). Thousand Oaks, CA: Sage, 2003.

¹¹ Brutscher, P.-B., S. Wooding and J. Grant. *Health research evaluation frameworks. An international comparison*. Cambridge, UK: RAND Europe, 2008. http://www.rand.org/pubs/technical_reports/TR629 [Date accessed: 16 December 2010]

¹² Buxton, M. and S. Hanney. “How can payback from health services research be assessed?” *Journal of Health Services Research and Policy*, 1 (1996): 35-43.

¹³ Wooding, S., S. Hanney, M. Buxton and J. Grant. “Payback arising from research funding: Evaluation of the Arthritis Research Campaign.” *Rheumatology* 44 (2005): 1145-56. Nason, E., B. Janta, G. Hastings, S. Hanney, M. O’Driscoll and S. Wooding. *Health research – making an impact. The economic and social benefits of HRB-funded research*. Dublin: Health Research Board, 2008.

Table S.1
Summary of the impacts arising from case study grants

AUSTRALIA	CANADA	UK
All Australian projects produced peer-reviewed publications, e.g. a project on immunoelectron microscopy of amine and peptide synapses on sympathetic preganglionic neurons resulted in 18 articles that have received a total of 780 citations.	All Canadian projects produced peer-reviewed publications, e.g. a project on the determinants of increased growth of vascular smooth muscle in spontaneously hypertensive rats produced a series of journal articles. Sixteen articles produced 849 citations and included a paper in the highly prestigious <i>Journal of Clinical Investigation</i> .	All UK projects produced peer-reviewed publications, e.g. a project on the role of coagulation and fibrinolysis in the pathogenesis of recurrent stroke led to a series of articles, seven of which have been cited 393 times in total.
All Australian projects led to research capacity building and/or targeting, e.g. a project on high density lipoprotein (HDL) led to collaborations for the PI and advanced the career of the post-doc; it also resulted in new research techniques, further research funding for the group and better targeting of other groups through increased understanding of HDL.	All Canadian projects led to research capacity building and/or targeting, e.g. a project on the effects of simulated stroke on developing astrocytes led to two PhDs; techniques were taught.	All UK projects led to research capacity building and/or targeting, e.g. the project (above) led to two PhDs, an MD and development of a patient cohort and control group that formed the basis of a stream of work. It helped the PI establish his research group.
All Australian projects contributed to informing policy and/or product development, e.g. a project that created animal models for myocardial dysfunction contributed to the decision to create a transgenic facility at the research institute, and eventually a commercial facility.	Eleven of the 12 Canadian projects contributed to informing policy and/or product development, e.g. guidelines recommend a treatment pathway for antiphospholipid antibodies (APLA) based on the original warfarin-based project.	Four of the nine UK projects contributed to informing policy and/or product development, e.g. a project on stroke prevention in the elderly in primary care informed guidelines in a working group statement and protocols of local units in the health service.
All Australian projects contributed to health gains, e.g. a project studying the follow-up to heart attacks contributed to a major international project on health promotion, which in turn contributed to a decline in coronary heart disease in the Hunter region.	Seven of the 12 Canadian projects contributed to health gains, e.g. the treatment path for APLA patients is much improved, leading to some health gain.	Four of the nine UK projects contributed to health gains, e.g. a project analysing the automated defibrillators in Scotland's ambulances is widely cited in policies and made an important contribution to the increased survival rate following out-of-hospital cardiac arrest.
Five of the eight Australian projects contributed to economic benefits, e.g. the commercial transgenic facility developed as a result of the animal models for myocardial dysfunction is now a multi-million-dollar business that exports 80% of its services.	Two of the 12 Canadian projects contributed to economic benefits, e.g. a project used a radioimmunoassay the PI had created previously: later sold by a commercial company.	Three of the nine UK projects contributed to economic benefits, e.g. the increased life expectancy of patients with Marfan syndrome has mostly been among people of working age; therefore a number of people have been able to remain active in the workforce.

large enough to rule out outcomes or differences that could have arisen by chance. Because of this, we have been deliberately cautious in interpreting our data and have tested the strength of any associations leading to policy observations. Other limitations include potential inconsistencies in case study reporting and possible confounders; for example, the definitions of basic biomedical and

clinical research used, the scope of the case studies and the effects of negative findings. Equally there are significant strengths in the study method chosen, particularly in comparison to other sources of information on research funding policy. These strengths include the use of the Payback Framework to encourage consistency across cases and facilitate comparative analysis; quality

assurance checks to ensure consistency across an international team; and consideration of both quantitative and qualitative case study material.

Key findings and policy implications

The five key findings from the study are as follows.

1. The cases reveal that a large and diverse range of impacts arose from the 29 grants studied.
2. There are variations between the impacts derived from basic biomedical and clinical research.
3. There is no correlation between knowledge production and wider impacts.
4. The majority of economic impacts identified come from a minority of projects.
5. We identified factors that appear to be associated with high and low impact.

1. The cases reveal that a large and diverse range of impacts arose from the 29 grants studied

As illustrated in Table S.1, there is a considerable range of research paybacks associated with the grants studied, and many of these would not have been identified without the structured, case study approach used in this study. This resonates with the diversity of payback identified in an earlier study on arthritis research.¹⁴

2. There are variations between the impacts derived from basic biomedical and clinical research

In the cases studied, basic biomedical research has a greater academic impact and clinical research a greater wider impact over the time-scales investigated. All the grants studied had academic impact, but the average rating was higher in basic biomedical research than in clinical research. For the combined wider impact categories all clinical studies had some impact, compared to only six out of 15 basic biomedical case studies. This finding should be treated with caution as it may be con-

founded by longer time lags for basic biomedical research.

3. There is no correlation between knowledge production and wider impacts

There is no correlation between the payback category, “knowledge production”, and the three wider categories, “informing policy and product development”, “health and health sector benefits” and “broader economic benefits”. From a policy perspective this would suggest that the level of knowledge production is not a predictor of wider impacts.

4. The majority of economic impacts identified come from a minority of projects

Only four of the 29 case studies reported substantial broader economic benefits and 19 grants had no impact in this payback category. It is important that these distributional effects are understood in any assessment of research impact. Although the majority of economic impacts come from a small proportion of projects, we previously found that the value of the impact achieved from a programme of research overall can significantly outweigh the costs of doing the research.¹⁵

5. We can identify factors that appear to be associated with high and low impact

We have identified a number of factors in cardiovascular and stroke research that are associated with higher and lower academic and wider impacts. These are captured in Table S.2, each with an associated policy implication for research funders and policy makers to consider.

Just as science is the effort to discover and increase human understanding of how the world works and how we can influence it, science policy should be about understanding how the world of science works and how we can influence it to maximise benefits for society. Studies like Project Retrosight contribute to the growing field of the “science of science”, providing an evidence base to inform research funders in their decision making.

¹⁴ Wooding, S., S. Hanney, M. Buxton and J. Grant. *The returns from arthritis research. Volume 1: Approach, analysis and recommendations*. Cambridge, UK: RAND Europe, MG-251-ARC, 2004.

¹⁵ HERG, Office of Health Economics and RAND Europe. *Medical research: what's it worth? Estimating the economic benefits from medical research in the UK*. UK Evaluation Forum, 2008.

Table S.2**Factors associated with high- and low-impact research**

Factor	Policy implication
Basic biomedical research with a clear clinical motivation is associated with high academic and wider impacts	When seeking to achieve high academic and wider impacts, encourage and support clinically motivated basic biomedical research
Co-location of basic biomedical research in a clinical setting is associated with high wider impact	When seeking to achieve high wider impacts from basic biomedical research, encourage and support the co-location of basic biomedical researchers with clinicians in a clinical setting (e.g. a teaching hospital or health organisation)
Strategic thinking by clinical researchers is associated with high wider impact	When seeking to achieve high wider impacts from clinical research, focus clinical research funding on PIs or teams who think strategically about translation into clinical practice
Research collaboration is associated with high academic and wider impact	When seeking to achieve high academic and wider impacts, encourage and support research collaboration for both basic biomedical and clinical research
International collaboration is associated with high academic impact	When seeking to achieve high academic impact, encourage and support international collaboration for both basic biomedical and clinical research
Engagement with practitioners and patients is associated with high academic and wider impacts	When seeking to achieve high academic and wider impacts, encourage and support clinical researchers who have a record of engaging with practitioners and patients
Basic biomedical research collaboration with industry is associated with high academic and wider impacts	When seeking to achieve high academic and wider impacts from basic biomedical research, encourage and support collaboration with industry
Negative or null findings are associated with low academic and wider impacts	Research funders should acknowledge the importance and potential significance of negative or null findings when assessing the impact of research
Initial rejection of a subsequently accepted basic biomedical research grant may be associated with low academic and wider impacts	Further research is needed to confirm whether initial rejection of a research proposal is associated with low impact. Until this finding can be confirmed or refuted, funders may want to carefully consider such proposals

Acknowledgements and detailed authorship

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This study was initiated with internal funding from RAND Europe and HERG, with continuing funding from the UK National Institute for Health Research, the Canadian Institutes of Health Research, the Heart and Stroke Foundation of Canada and the National Heart Foundation of Australia. The UK Stroke Association and the British Heart Foundation provided support in kind through access to their archives.

Project Retrosight team

Jonathan Grant (RAND Europe), Martin Buxton (HERG), Stephen Hanney (HERG) and Steven Wooding (RAND Europe) devised the methodological approach and analysis with input from the Retrosight Team. Steven Wooding managed and coordinated the project, supported by Eddy Nason (RAND Europe), Sharif Ismail (RAND Europe), Sue Kirk (RAND Europe) and Alex Pollitt (RAND Europe). Statistical analysis was provided by Laura Staetsky (RAND Europe).

The Australian case studies were carried out by Rob Mercer (Instinct and Reason), Angela Mitchell (Instinct and Reason) and Christine Latif (National Heart Foundation of Australia); the Canadian studies by Laura McAuley (Can-

dian Institutes of Health Research), Heather Mustoe (Canadian Institutes of Health Research) and Kimberly-Anne Ford (Canadian Institutes of Health Research); the UK studies by Stephen Hanney, Sharif Ismail, Sue Kirk, Sonja Marjanovic (RAND Europe) and Eddy Nason. The case study bibliometric analysis was coordinated by Linda Butler (Australian National University) and Sharif Ismail and carried out by Kumara Henadeera (Australian National University) and Thed van Leeuwen (CWTS).

Quality assurance

Tom Ling (RAND Europe) and Chris Henshall (Brunel University and the University of York) acted as our quality assurance reviewers and provided thoughtful, constructive and timely criticism.

Steering group

The project steering group consisted of Peggy Borbey (Canadian Institutes of Health Research), Sally Brown (Heart and Stroke Foundation of Canada), Martin Buxton, Ian Graham (Canadian Institutes of Health Research), Jonathan Grant, Stephen Hanney, Christine Latif, Laura McAuley and Linda Piazza (Heart and Stroke Foundation of Canada).

Report writing

The report was drafted by David C. Taylor (Cambridge Editorial) working with the RAND Europe and HERG project teams, edited by Sally Simmons (Cambridge Editorial) and designed by Paul Barrett Book Production.

Five babies were born to members of the project team during Project Retrosight: Noah Grant Sanz, Alex Robert Wooding, Kaya Diane Hipwell, Lena Grae Simpson, and Daniel Peter Wooding.

Consortium members

A large number of organisations supported Project Retrosight.

RAND Europe

RAND Europe is an independent not-for-profit policy research organisation that helps improve policy and decision making through research and analysis. Its clients are European governments, institutions, foundations and companies with a need for rigorous, impartial, multidisciplinary analysis.

HERG

The Health Economics Research Group is a Specialist Research Institute of Brunel University dedicated to conducting accessible, policy-relevant research of a high academic quality focused on improving the efficiency and cost-effectiveness of resources devoted to health care and to research.

NIHR

The goal of the National Institute for Health Research (NIHR) is to create a health research system in which the National Health Service (NHS) supports outstanding individuals, working in world-class facilities, to conduct cutting-edge research focused on the needs of patients and the public.

CIHR

The Canadian Institutes of Health Research (CIHR) is the Canadian government's agency responsible for funding health research. CIHR was created in 2000 under the authority of the CIHR Act and reports to parliament through the Minister of Health. CIHR is comprised of 13 institutes and supports 13,000 researchers and research trainees. CIHR's mandate is to "excel, according to internationally accepted standards of scientific excellence, in the creation of new knowledge and

its translation into improved health for Canadians, more effective health services and products and a strengthened Canadian health-care system".

HSFC

The Heart and Stroke Foundation of Canada is a federation of 10 provincial foundations with a federation office in Ottawa, led and supported by more than 130,000 volunteers. The mission of HSFC, a volunteer-based health charity, is to lead in eliminating heart disease and stroke and reduce their impact through the advancement and application of research and the promotion of healthy living and advocacy.

National Heart Foundation of Australia

The National Heart Foundation of Australia is a non-profit organisation with a mission "to reduce suffering and death from heart, stroke and blood vessel disease in Australia". Established in 1959, the National Heart Foundation of Australia funds world-class cardiovascular research, supports health professionals in their practice, develops health promotion activities, informs and educates the public and assists people with cardiovascular disease.

Instinct and Reason

Instinct and Reason is a global research consultancy that works with private, public sector (state and federal) and not-for-profit organisations. Instinct and Reason specialises in both domestic and international market, social and economic research and has offices in Canberra, Sydney, New York and London.

The Research Evaluation and Performance Project

The Research Evaluation and Performance Project was a research unit of the Australian National

University, focusing on the development of methods to assess the impact of research, with a particular expertise in bibliometric methods.

The Centre for Science & Technology Studies

The Centre for Science & Technology Studies (CWTS) is a research institute within the Leiden University Faculty of Social Sciences. CWTS is a leading research institute in the field of scientometrics and bibliometrics, whose bibliometric techniques are frequently used in research assessment procedures. CWTS's clients include international organisations, governments and research groups both inside and outside the Netherlands.

Stroke Association

The Stroke Association campaigns, educates and informs to increase knowledge of stroke at all levels

of society, acting as a voice for everyone affected by stroke. The charity funds research into prevention, treatment and better methods of rehabilitation; it helps stroke patients and their families directly through its community support services as well as providing information through its helpline, leaflets and factsheets.

British Heart Foundation

The British Heart Foundation is the nation's heart charity, dedicated to saving lives through pioneering research, patient care, campaigning for change and by providing vital information. It works alongside government, other health charities, health professionals and thousands of dedicated supporters to beat heart disease.

Chapter 1 Introduction

Project Retrosight addresses two key challenges facing those involved in supporting and funding research – understanding and predicting the impacts of research and how to support researchers in having greater impacts (Grant and Wooding, 2010). It has its home in the growing field of the “science of science” and seeks to shed light on what works in research funding (Marburger, 2005; Macilwain, 2010). The “science of science” is concerned with research success and how that success leads to improvements, or impact, in the real world. It aims to understand if there are characteristics that predict impact and, if so, what those characteristics are. It aims to discover what kinds of research, researcher, setting and support are most successful in ensuring the scientific success of research and its translation into societal benefits.

The origins and aims of Project Retrosight

The idea that became Project Retrosight grew from conversations between Martin Buxton and Jonathan Grant during breaks in a 1999 workshop on research impact organised in Banff, Canada, by the Alberta Heritage Foundation for Medical Research (now Alberta Innovates – Health Solutions). The name Project Retrosight is derived from two landmark studies in science policy. The first – Project Hindsight (Sherwin and Isenson, 1967) – was a study sponsored by the US Department of Defense that examined the incremental advances of various technologies. The second was Julius Comroe’s book, *Retrospectroscope: Insights into Medical Discovery* (Comroe, 1977). Comroe examined new life-saving advances in medicine and how they had come about. At the same time, in a more or less direct response to Project Hind-

sight, he worked with Robert Dripps to trace the research antecedents of clinical advances in cardiovascular medicine. This study was described in an article in *Science* (Comroe and Dripps, 1976). The idea of Project Retrosight was to develop these ideas by tracing prospectively, with the benefit of hindsight, the translation of, and payback from, funded research projects.

Conceived in 1999, Project Retrosight was several years in gestation. Work finally started on the project in 2007 as a cooperation between the Health Economics Research Group (HERG) at Brunel University and RAND Europe, with the support and involvement of various consortium members (see Acknowledgements page).

Building on successful methodologies used to evaluate research in diabetes (Hanney et al., 2006) and arthritis (Wooding et al., 2005), the project aimed to:

- examine the variety of payback produced by basic biomedical and clinical cardiovascular and stroke research;
- identify factors associated with high (and low) levels of payback, in particular factors relating to the characteristics of the research, how it was supported or the context in which it was carried out;
- the significance of country context in the process of translation and production of payback. Ultimately, it did not prove possible to carry out cross-country analysis; the reasons for this are discussed in the International Approach section on page 18.

Our intention was to contribute to the evidence base that describes how research translation and impact actually comes about, in the hope that the evidence could inform subsequent funding decisions.

The organisation of this report

In this chapter, we contextualise the burden of cardiovascular and stroke disease and discuss why it is important to understand the impact of research and to identify factors that lead to high levels of impact. We outline the background to the Payback Framework – the conceptual framework we chose as the basis for the analysis in Project Retrosight.

Chapter 2 outlines the key stages of the approach we took to our research, while Chapter 3 is a critique of our methodology, covering some of the key challenges the study faced and how we addressed them. It includes a discussion of the possible confounding factors in our analysis. In Chapter 4 we review what we see as the key messages to be drawn from the study.

This Policy Report is accompanied by a detailed Methodology Report (Pollitt et al., 2011a) and the full case studies are available in a Case Study Report (Pollitt et al., 2011b).

The burden of cardiovascular and stroke disease

The term *cardiovascular disease and stroke* has been used throughout this report to highlight the notion that stroke is often considered an independent area of research, outside the field of heart and blood vessel disease.

As Table 1.1 shows, cardiovascular diseases are leading causes of death in Australia, Canada and the UK, responsible for about one third of all deaths in all three countries. Attributable mortality for stroke averages around 8%. Table 1.1 presents a combined picture of the burden of cardiovascular and stroke disease in three countries, rather than a comparison. Reported differences in disease prevalence among the three countries are due in part to differences in the age standardisation method (or lack of age standardisation); data collection methods (e.g. surveys plus medical records, medical records only, etc.); and characteristics of samples chosen. Economic costs also use slightly varying definitions, which prohibit direct comparison. What is clear from Table 1.1 is the considerable burden that cardiovascular and stroke disease represents for all three countries, and the associated importance of cardiovascular and stroke research.

The need to understand research

Governments and health research charities aim to improve our understanding of health and disease, and thus population health and well being through basic biomedical and clinical research. We consider health research to range from basic biomedical research through to clinical and health services research. There is widespread public support for health research funding (Wellcome Trust, 2010). However, research is expensive and in many countries there is a growing emphasis on making research policies more evidence based and increasing accountability for research funders and researchers. Funding bodies are under increasing pressure to justify research spending by showing how it benefits society through improvements to health and economic growth. Pressure to demonstrate the optimum use of research funds and the payback from research spending is further increasing, partly as a result of the economic downturn in some countries leading to a tightening of government expenditure (Weissberg, 2010) and pressure on donor contributions to charities.

This emphasis on accountability throws into sharp focus the major recurring challenge facing those involved in science and science policy: how best to spend research money. Although there is general agreement that improved knowledge and understanding should lead to health improvements and other benefits, there is little understanding of how this occurs.

Consequently, there is a pressing need to undertake studies that can shed light on how money spent on research is ultimately translated into societal benefits, including health improvements, and to improve understanding of this translation process. Such studies aspire to take us beyond the many commentaries that claim there are benefits from research without thoroughly investigating how these come about (reviewed in Boaz et al., 2009). A recent review (Hanney et al., 2007) of the available literature (in English) identified fewer than 50 reports describing approaches to evaluating the impact of health research programmes, or the empirical evaluation of a particular programme of health research. This group included several studies that were small in scale and based on limited data. So it is fair to say that there is an important role for further rigorous studies to bolster the portfolio of evidence on the

Table 1.1
The burden of cardiovascular and stroke disease and associated research funding

	Australia	Canada	United Kingdom
Mortality			
Attributable mortality (CVD, all deaths)	38%	30%	35%
Men	39%	31%	34%
Women	34%	30%	34%
Attributable mortality (CBV/stroke)	9%	6%	11%
Men	7%	5%	9%
Women	12%	8%	13%
Morbidity			
Prevalence in adults (CVD)	18% ^c	5% ^d	13% ^e
Men	16% ^c	5% ^d	14% ^e
Women	20% ^c	4% ^d	13% ^e
Prevalence in adults (CBV/stroke)	1%	1%	2%
Men	1%	1%	2%
Women	1%	1%	2%
Economic impact (converted to US dollar equivalents)			
Total annual cost to national economy (all CVD)	\$10.5bn	\$15.0bn	\$53.3bn
Direct costs (treatment)	\$5.6bn	\$5.1bn	\$28.8bn
Indirect costs (loss of productivity, informal care)	\$4.9bn	\$9.8bn	\$21.3bn
Percentage of health spending (public only; direct costs of CVD)	11%	17%	21%
Annual research spending (converted to US dollar equivalents)			
All CVD, total spending	\$120.9m ^a	\$66.6m ^a	\$191.5m ^b
All CVD, spending per capita	\$6.01	\$2.38	\$3.20

^a Government-funded only; data from other funding sources not readily available

^b Government and major charity-funded

^c Age 14 and over

^d Age 12 and over; data from Statistics Canada's Canadian Community Health Survey (CCHS) which measures self-reported accounts of 'heart disease', and does not include CBV

^e Age 16 and over

Sources:

Australia: *Heart, stroke and vascular diseases: Australian facts 2004*. Canberra: Australian Institute of Health and Welfare, 2004; *National Health Survey: Summary of Results, Australia, 2004–05 cat. no 4364.0*. Australian Bureau of Statistics, 2006; Vos, T. and Begg, S. *The burden of cardiovascular disease in Australia for the year 2003 (revised 2007)*. Centre for Burden of Disease and Cost-effectiveness, University of Queensland School of Population Health. National Heart Foundation of Australia, 2006; *Women and heart disease: Summary*. Australian Institute of Health and Welfare, June 2010. Available at: <http://www.aihw.gov.au/publications/index.cfm/title/11193> [Date accessed 17 December 2010]; *Health expenditure Australia 2006–07*. Australian Institute for Health and Welfare, 2008. Canberra: AIHW.

Canada: Dai, S., Bancej, C., Bienek, A., et al. *Tracking Heart Disease and Stroke in Canada*. Public Health Agency of Canada, 2009; *Decline of cardiovascular disease*. The Heart and Stroke Foundation, 2010. Available at: <http://www.heartandstroke.com/site/c.ikiQLcMWJtE/b.3483991/k.34A8/Statistics.htm#heartdisease> [Date accessed 17 December 2010]; *Statistics Canada CANSIM Table 102-0529: Deaths, by cause, Chapter IX: Diseases of the circulatory system (100 to 199), age group and sex, Canada, annual (number), 2000 to 2006*. May 2010; *Heart Disease*. CIHR. Available at: http://www.cihr-irsc.gc.ca/e/documents/heart_disease_mpk105_e.pdf [Date accessed 17 December 2010]

UK: Allender, S., Peto, V., Scarborough, P., et al. *Coronary heart disease statistics*. British Heart Foundation: London, 2008; *Deaths by cause, sex and age, 2007*, United Kingdom. Office for National Statistics, 2008; *Health Survey for England 2006: CVD and risk factors adults, obesity and risk factors children*. The NHS Information Centre, January 2008; *UK Health Research Analysis*. UK Clinical Research Collaboration, 2006. Available at: <http://www.ukcr.org/researchcoordination/healthresearchanalysis/ukanalysis/> [Date accessed 17 December 2010]

nature and mechanisms of the impacts made by health research.

To provide an evidence base to help inform funders' decisions we need studies that explore which features of research, and translation processes, deliver these benefits. It is important that such studies seek to improve the effectiveness of funding rather than simply making the case for increasing, or maintaining, research support. As John Marburger, the former science advisor to President George W. Bush, put it in an editorial in *Science*: "A new 'science of science policy' is emerging ... But [this] demands the attention of a specialist scholarly community. As more economists and social scientists turn to these issues, the effectiveness of science policy will grow, and of science advocacy too" (Marburger, 2005).

Previous work relevant to this study can be split into two main groups: studies working back from breakthroughs to identify research, and studies working forwards from research to identify impact. The latter group divides into collections of studies using different conceptual models, of which the Payback Framework is one. A separate distinction is that while all studies explore the impact of

Figure 1.1
The five payback categories

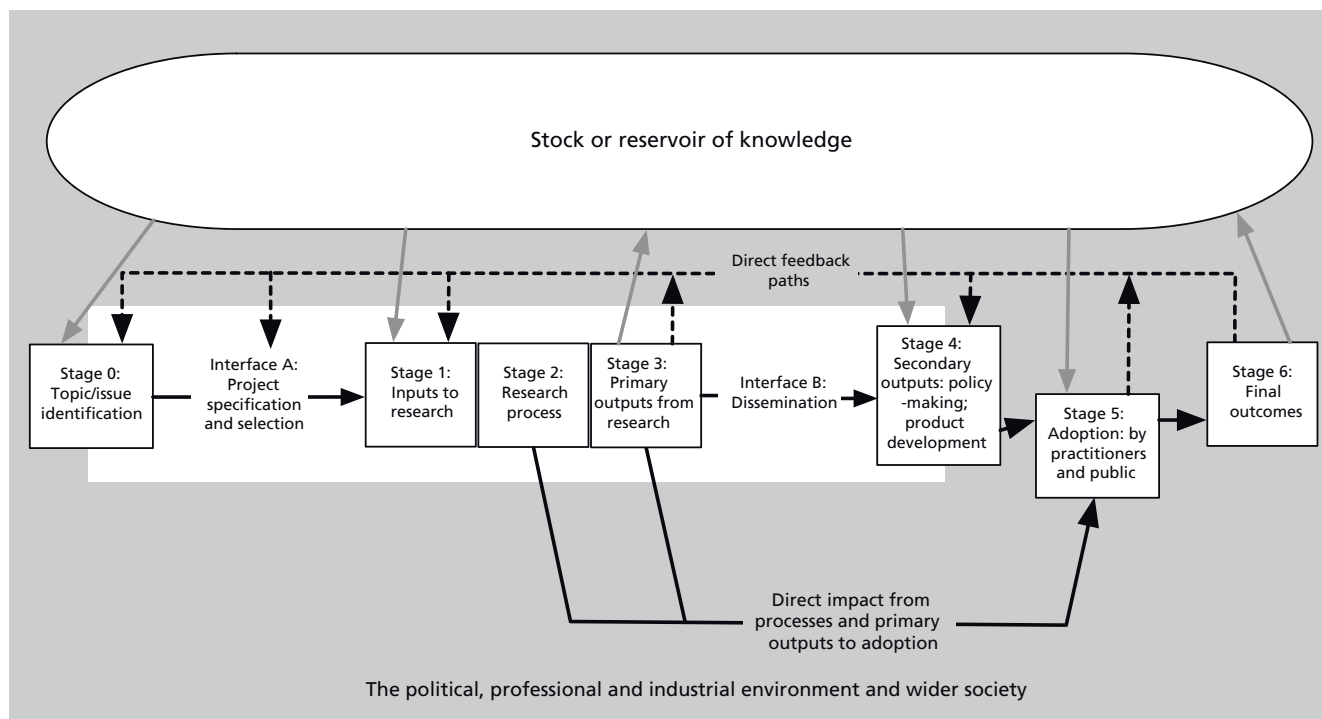


research, only some also attempt to identify factors associated with success or payback – however defined. In the next section we concentrate on the most relevant aspect for this study, the use of the Payback Framework and the use of quantitative measures of impact to help identify factors associated with research payback. More detail on the remaining groups of previous work is provided in our earlier report (Marjanovic et al., 2009).

The Payback Framework

There is a variety of approaches in the literature to identifying the payback from research, rang-

Figure 1.2
The Payback Framework's logic model of the research funding process



SOURCE: Hanney et al., 2004

ing from individual case studies, through logic models, to econometric modelling (Hanney et al., 2007; Boaz et al., 2009; UK Evaluation Forum, 2006; Committee on Science Engineering and Public Policy et al., 1999). These methods vary in the range of paybacks they consider and the extent to which they attempt to understand how that payback arises. The Payback Framework takes a wide definition of research payback running from the generation of new knowledge in academic papers through to societal and economic benefits (Buxton and Hanney, 1996; Hanney et al., 2004). It categorises these paybacks into five payback categories (shown in Figure 1.1).

Alongside this it attempts to understand how these benefits arise through a standardised logic model of the research funding process (shown in Figure 1.2).

The Payback Framework has the advantage of covering a wide range of the paybacks from research, and allowing cross-case comparisons by providing a uniform classification of paybacks and narrative structure. When used to structure case studies, as for Project Retrosight, it allows deep exploration of the circumstances and context of the research, from a variety of sources, as well as nuanced treatment of issues such as the contribution of research to particular paybacks (Croxon et al., 2001; UK Evaluation Forum, 2006).

The Framework has also shown itself to be suitable, with slight modification, for use in a range of research contexts from basic biomedical research through health services research, including social science and research in the arts and humanities (Wooding et al., 2004, 2005, 2006; Hanney et al., 2007; Levitt et al., 2010).

Increasingly the Payback Framework has been supplemented by methods for quantifying the level of payback, to facilitate cross-case comparisons and to allow the identification of factors that are associated with high payback, and so might be predictive of it. Its five payback categories allow this quantification to be done in a way that acknowledges that different paybacks may be of interest to different stakeholders. Our study builds on and develops those methods of quantification.

These characteristics have contributed to the Framework's widespread adoption outside the UK, including the CIHR Impact Assessment Framework, the Netherlands, Ireland and Hong Kong (Oortwijn et al., 2008; Nason et al., 2008; Kwan et al., 2007). In Canada the Canadian Academy of Health Sciences panel on return on investment in health research based their recommendations for all users and supporters of health research on the Payback Framework (Panel on Return on Investment in Health Research, 2009).

We discuss how we assembled our payback case studies in more detail in Chapter 2.

Chapter 2 Methods

This chapter provides an overview of our approach, alongside some of the checks we carried out to ensure the robustness of our data. We first discuss how we selected our methods, and in particular the Payback Framework as our approach; how we identified the subject area and countries to examine; and how we selected the funding period to focus on. We then step through the stages of our approach: identifying lists of research grants; estimating the payback of each grant through a survey of principal investigators (PIs); selecting a stratified random sample of grants; carrying out the case studies; quantifying the payback in each case; deriving impact categories for our analysis; and finally identifying common factors associated with payback. Our approach is presented diagrammatically in Figure 2.1. For more detail on the methods please see the accompanying Methodology Report (Pollitt et al., 2011a).

Selecting our methods

The case study approach, combined with a robust sampling framework and a method for quantifying our qualitative data, provided us with a way to understand the quantity and diversity of paybacks from the research and the context that led to them. We built up a detailed picture of each grant, how the research progressed and how it developed – a case study approach has often been used to address questions of research translation (Boaz et al., 2009). The case studies subsequently provided us with a rich source of material to examine for factors associated with payback. By using case studies, we effectively emphasised depth of understanding about a small sample of grants. In contrast we could have used surveys, or other methods, to collect a smaller set of information about more cases, i.e. we could have emphasised breadth. We chose to focus on depth because we wanted to

understand the potentially subtle or unanticipated contextual factors that affected translation.

We selected the Payback Model in particular based on previous work where we surveyed the available evaluation frameworks (Brutscher et al., 2008). As noted in Chapter 1, in the Payback Framework section, this choice has also been endorsed by the widespread adoption of the Payback Model both in the UK and internationally.

Identifying a subject area, countries and funders

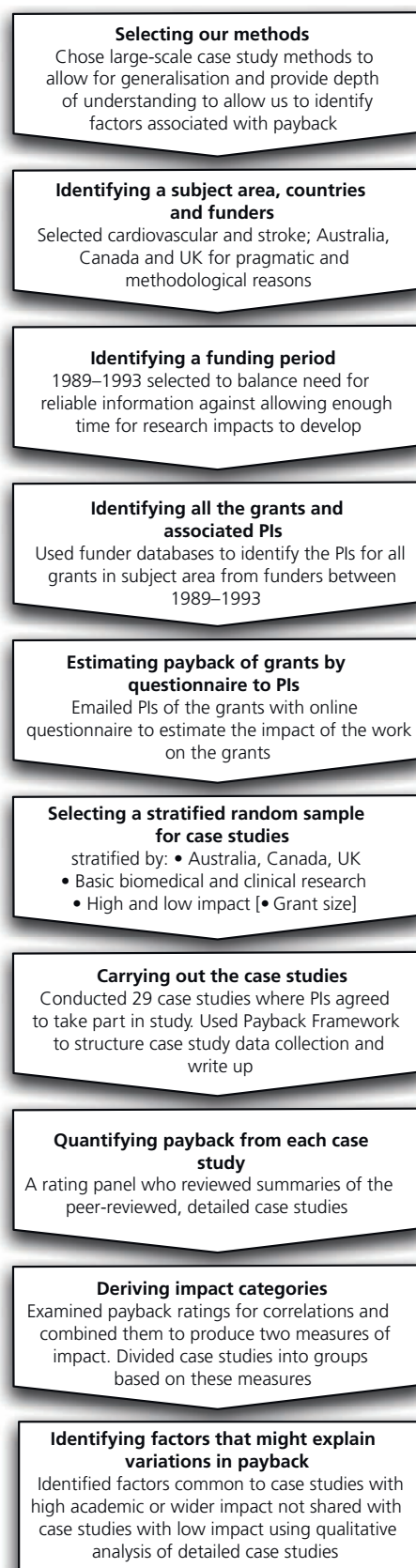
These processes effectively happened in parallel. We were keen to focus on an area of research, such as cardiovascular and stroke, that has large health benefits and potential impact (as outlined in the Introduction). Fortuitously, there was sufficient interest among funders in this area to support a study and it proved possible to build a consortium of interested parties. Our country selection was driven largely by the availability of funders interested in supporting the project – but had the advantage of including research systems of comparable size, all working in the same language. It is also worth noting that the cardiovascular and stroke area has also been the subject of previous studies in the science of science (Comroe & Dripps, 1976; HERG et al., 2008).

Identifying a funding period

We chose grants as our unit of analysis because we wanted to be able to link payback to funding and also because available grant lists provided a population from which to sample our case studies. We opted to focus on project grants/grants-in-aid to restrict the variety of funding in our sample.

We also had to decide how old the grants we studied should be, and selected an age range of

Figure 2.1
A diagrammatic summary of the project methods



17–20 years, that is, grants with first-year funding awarded between 1989 and 1993. We did this to balance the need for reliable information against the need to allow enough time for research paybacks to develop. We also bore in mind studies examining the time lag between research and payback, which suggest that timescales of 15–20 years are the norm (Di Masi et al., 1991; Grant et al., 2000; Balas and Boren, 2000; Contopoulos-Ionnadis, 2008; HERG et al., 2008).

Identifying all the grants and associated PIs

We combined grants awarded between 1989 and 1993 by all members of the consortium: the National Heart Foundation of Australia; the Heart and Stroke Foundation of Canada; the Canadian Institutes of Health Research; the British Heart Foundation; and the UK Stroke Association. This gave us a list of 1347 grants.

Estimating payback of grants by questionnaire to PIs

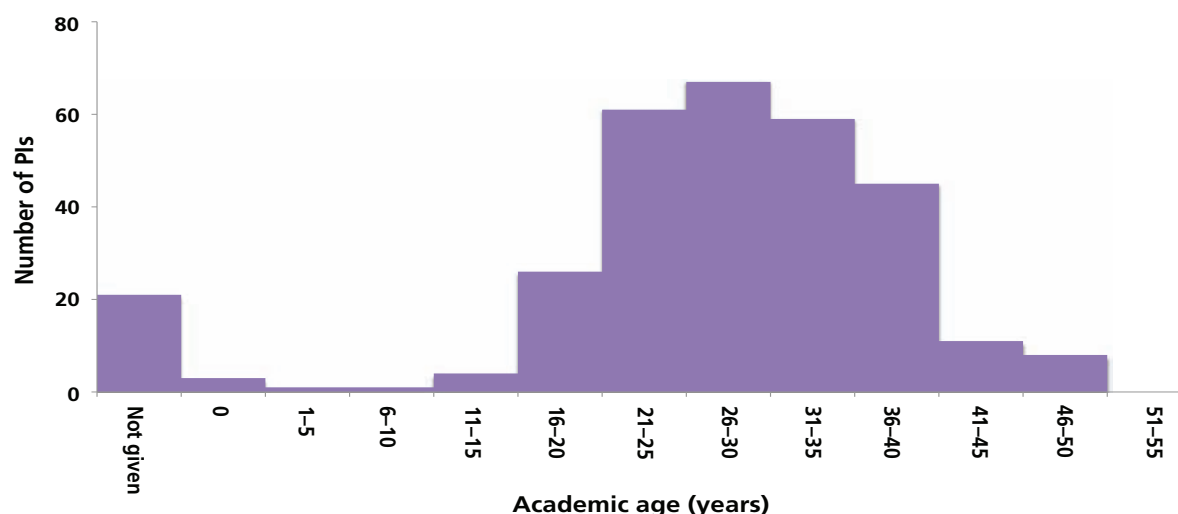
To ensure robust identification of factors associated with payback we needed to include case studies with a range of payback levels. We used a web-based survey that asked PIs a series of brief questions about impacts arising from their grants, from the number of papers published to effects on patient or public health. From their answers we made an initial estimate of payback for each grant. We also asked PIs to classify their grants as basic biomedical or clinical research, according to a standard definition we provided (see Figure 2.2).

We approached PIs by email, having obtained their address either directly from funder records

Figure 2.2
Definition of research type

Research	Definition
Basic biomedical	Focuses on normal or abnormal function at the molecular, cellular, organ or whole body level
Clinical	Focuses on patients, on better diagnostics or treatments, and on increasing quality of life

Figure 2.3
A histogram showing the total number of years the PIs responding to our survey had spent in research by 2007



(Canada and Australia) or through Google and Web of Science (Thomson Reuters) searches (UK). For pragmatic reasons in the UK we focused our efforts to locate email addresses on researchers who had published in the period 2004–6, as determined through searches of Web of Science.

We worked hard to minimise the biases in our sample; however, some will remain. The extent of these is hard to quantify; but our list of candidate case studies contained researchers with a wide distribution of academic age (Figure 2.3) and our case studies contain PIs at a range of career stages, from pre-PhD through post-doc to head of department.

Selecting a stratified random sample for case studies

We selected our case studies randomly after stratifying the grants according to the characteristics of research type (basic biomedical or clinical), estimated payback (higher or lower) and country.

The challenge with case study research is producing findings that are transferable. This arises because case studies are carried out in small numbers (so may not be representative of the full range of possible case studies) and they are often selected purposively. In order to increase the likelihood that our findings would be transferable, we carried out a relatively large number of case studies,

stratified our sample by the key characteristics we wished to analyse and then carried out a random case selection.

Key characteristics

We stratified the case studies by the following characteristics: basic biomedical versus clinical research, estimated payback, country of research and grant size.

Type of research (basic biomedical vs clinical) – the relative merits of these two types of research is a perennial question for research funders.

Country of research – the project gave us an opportunity to examine whether the role of national context plays a significant role in research payback.

Payback of research – we wanted to ensure we had a balance of levels of payback in the case studies that would provide us with a solid basis to identify factors associated with impact. Such a sample would allow us to look for factors shared between higher-payback case studies, but not with lower-impact case studies. If we had used a purely random selection we could easily have ended up without this balance of payback levels. We saw this as a key methodological development as most research evaluation looks at high-impact research without a low-impact comparison.

Grant size – to allow us to explore the relative merits of grants of different sizes. However, in later

analysis this proved problematic as the range of sizes was relatively small, differed between countries and was not always available for this retrospective sample in funders' records. For these reasons we have not attempted any analysis based on this stratification characteristic.

We carried out the stratified random selection by populating the selection matrix shown in Figure 2.4 for each country and then randomly selecting a case study from each cell.

There were three amendments to this process: as Canadian team members were able to perform additional case studies, we selected more case studies in Canada; we selected researchers to balance the gender ratio seen in our survey; and the Australian and Canadian team members felt it was important to have a geographical spread of case studies to mirror the distribution of their funding by region at that time (in effect we stratified for gender and, in Canada and Australia, for location; but did not analyse using these variables).

Two further factors slightly affected the sampling: an initial classification error and refusal to participate. An initial error in data extraction from the survey led to the misclassification of some grants, but because some of these case stud-

ies had been started by the time the error was corrected they were kept in the sample. This had a small effect on the distribution of cases across the matrix. Six PIs declined to participate in the study; in one other case, initial scoping following the PI's agreement to take part revealed that the grant did not meet our inclusion criteria. In one instance the case study research was initiated, and although three interviews were completed, insufficient evidence was available to allow compilation of a full case study report. This case was thus excluded from the sample. Finally, in one case the PI had moved to Japan and hence a face-to-face interview was not feasible. The net effect of these changes was to produce a study with 29 case studies, rather than 28 as originally intended, distributed across the selection matrix as shown in Figure 2.5.

Carrying out the case studies

We used the Payback Framework (see Chapter 1) to structure our case studies and drew on a variety of data sources. In each case we carried out a face-to-face interview with the PI, which was supplemented by other face-to-face and telephone interviews that may have included other members of the research team, their colleagues, collaborators and competitors, practitioners, or policy makers who used their work. Where available, we reviewed funder documents such as applications and end-of-grant reports (these records were sometimes provided by the PI if they were not available from the funder). We also reviewed PIs' publications from the grant period, and carried out a bibliometric analysis of publications attributed to the grant. Each case study is around 20 pages long and all are published in full in the accompanying Case Study Report (Pollitt et al., 2011b).

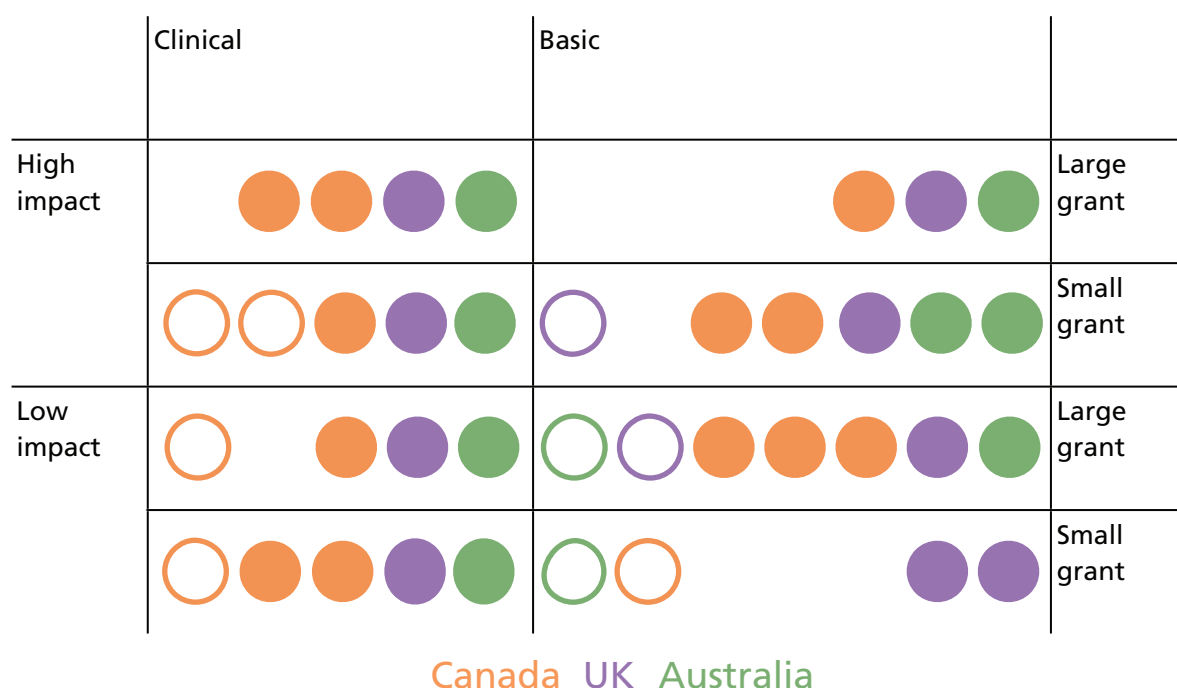
There was a separate team of case study researchers in each country. To improve consistency across the case study teams we held three international workshops, provided templates for interview schedules and write-ups, and two members of the UK team reviewed all initial drafts. To ensure historical accuracy the case studies were cleared by the PIs and underwent external peer review. We attempted to have each case study reviewed by two experts in the field of the case study's research – one from the same country as the case study and one from a different country. In the end 24 case studies were double- (or in two cases triple-) reviewed,

Figure 2.4
Selection matrix

	Clinical	Basic	
High impact	Quis nostris ut exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat Duis aute irure dolor in reprehenderit in voluptate velit Euse cillum dolore eu fugiat nulla pariatur Excepteur sint occaecat cupidatat non proident Sunt in culpa qui officia deserunt mollit anim id est laborum Duis aute irure dolor in reprehenderit in voluptate velit	Ipsa qui voluptas deserunt mollit anim id est laborum Duis aute irure dolor in reprehenderit in voluptate velit Euse cillum dolore eu fugiat nulla pariatur Consectetur adipiscing elit Sed do eiusmod tempor incididunt ut labore et dolore magna aliqua Ut enim ad minim veniam Excepteur sint occaecat cupidatat non proident Duis aute irure dolor in reprehenderit in voluptate velit	Large grant
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Figure 2.5

Final case study matrix: completed case studies are shown as filled circles, refusals and exclusions as open circles



and 5 cases were single-reviewed. For 23 of the 29 case studies one or more reviewers reported that the overall assessment of impact as described in the case study was accurate. In six case studies, one or more reviewers suggested slight overstatement of impact, in three cases significant overstatement, and in two cases slight understatement. The distribution of reviewers' comments is shown in more detail in Table 2.1.

Quantifying payback from each case study

We now had a set of 29 detailed case studies of research grants, and we wanted to use them to identify factors associated with payback. To do this we needed to determine which of our case studies had high payback and which low, so we could look for factors shared by the high payback cases and not shared with the others. We asked a panel of evaluators to rate each case study in each of the five payback categories – knowledge production, research targeting and capacity building, informing policy or product development, health and health sector benefit, and broader economic

Table 2.1
Reviewer comments

Reviewer assessment	Australia	Canada	UK
Significant understatement	0	0	0
Slight understatement	2	0	0
Accurate	10	15	15
Slight overstatement	1	3	2
Significant overstatement	3	1	0
Accuracy unclear to reviewer	3	4	0
Case studies with 1 reviewer	1	3	1
Case studies with 2 reviewers	6	8	7
Case studies with 3 reviewers	1	1	1
Total case studies	8	12	9
Total reviewers	16	22	18

Figures represent the number of reviews in which each assessment of the overall accuracy of a case study was made. Some reviewers made more than one comment (for example, on different aspects of the case study) and so are included more than once. Additionally, some reviewers did not provide an overall assessment and so are not included in the table.

benefit.¹⁶ In this section we describe how we quantified the payback for each case study.

First we recruited a panel of nine evaluators to rate our case studies. The panel was made up of both researchers familiar with the project and others new to it, who were invited to provide a degree of external validation. It included a case study researcher and an external expert on biomedical research funding from each project country, as well as one expert from a country not included in the project to provide an entirely independent perspective. The full membership of the rating panel is detailed in the accompanying Methodology Report (Pollitt et al., 2011a).

We provided raters with printed tables summarising the case study narratives and payback, the bibliometric analysis, an impact array of the paybacks and the peer reviewers' comments. We also supplied the full case studies and peer review comments in electronic form. We did not provide the panel with information on the PIs' initial payback estimates, as we wanted to produce an independent quantification of payback based on our case studies.

We asked the panel to provide a relative rating of the payback from each case study in each payback category – that is, five ratings per study. Each rating was on a scale of 0–9 where 0 was no payback, 1 was the least payback in the set of case studies and 9 the most. Raters had to give one case a 1 and one case a 9, thus ensuring full use of the scale and therefore variability, but could give more than one case study the same rating; ties were allowed. We chose to use a relative scale for the following reasons: because of the difficulty of developing absolute impact scales; because we felt ranking all 29 case studies in order would be too difficult; and because using an ordinal scale made it easy to present agreement measures (for more details see the Methodology Report). As we have a stratified random selection of case studies the range of payback in these should approximate the range of payback from the full set of project grants.

The panel provided an initial set of ratings that showed a considerable level of agreement. We then

brought them together for a two-day workshop in which we discussed the ratings over which there was most disagreement, and allowed the panel to rate the case studies a second time. The aim of the workshop was to reduce differences in understanding, for example, about the most appropriate classification of paybacks, but to preserve differences of opinion about the relative value of paybacks.

To give us confidence in the rating process we carried out a number of tests, reported in more detail in the Methodology Report. In summary, all members of the panel showed similar rating behaviour: they all used the full scale as directed, had median rates within one point of each other and their rating behaviour was not skewed. Agreement increased in the post-workshop ratings, although median rates changed only slightly: 79% of median ratings remained the same, 18% changed by 1, and 2% changed by 2 or 3. There was enough agreement in the median ratings to distinguish high-, medium- and low-impact groups, with around one third of case studies in each.

Deriving impact categories

Once we had quantified the payback in each category from each case study, we examined the median ratings to look for patterns. We were concerned that identifying factors associated with high impact in all five payback categories would be unmanageable and so, if possible, we wanted to reduce the number of payback measures. We found that grouping the first two and the last three payback categories allowed us to produce two mutually exclusive groupings that also grouped the payback categories with the highest correlation (see Table 2.2). From this we produced two impact categories: academic impact – encompassing knowledge production, research targeting and capacity building; and wider impact – encompassing informing policy and product development, health and health sector benefit and broader economic benefit (Figure 2.6).

Identifying factors that might explain variations in payback

To identify factors associated with impact we used our two impact measures – academic and wider – separately. For both measures we sorted case studies in order from high to low and then

¹⁶ We also rated the case studies on overall impact and value for money – these are discussed in more detail in the Methodology Report (Pollitt et al., 2011a), along with the reasons why we have not used them for analysis.

Table 2.2
The correlations between ratings in each payback category

	Knowledge production	Research targeting & capacity building	Informing policy & product development	Health & health sector benefits	Broader economic benefits
KP	1	0.424	0.112	0.106	0.036
RTCB	0.424	1	0.286	0.334	0.187
IPPD	0.112	0.286	1	0.748	0.441
HHSB	0.106	0.334	0.748	1	0.52
BEB	0.036	0.187	0.441	0.52	1

Coefficients in **bold italic** are significant at a 0.01 level
Spearman's rho and 2-tailed significance; n = 261 (29 projects x 9 raters)

divided them into three groups – high-, mid- and low-impact. Further detail on the process by which these groups were defined is provided in the accompanying Methodology Report (Pollitt et al., 2011a). High- and low-impact groups could then be compared to a series of binary variables representing the presence or absence of each factor in each case study. Grouping case studies in this way and focusing on the two “extreme” subgroups did mean that we did not use all of the data at the initial stage of analysis, but this is a well-established technique in scale development, and division into three groups to conduct such analysis is in line with the standard method for computing classical discrimination indices (e.g. Crocker and Algina, 1986). As there was some uncertainty in our impact measures we used a mid-impact group to ensure that we had a clear distinction between

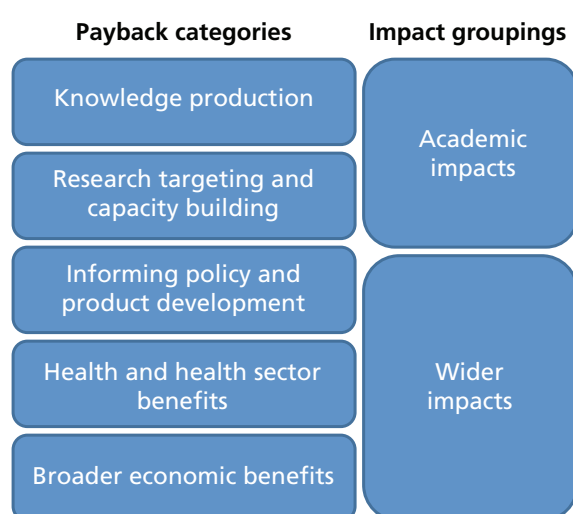
high- and low-impact cases, rather than two overlapping groups (see Figure 2.7 for a diagrammatic representation of the process).

This sorting process initially gave us six groups of case studies: three relating to academic impact (high, mid and low), and three relating to wider impact (high, mid and low). In line with the lack of correlation found between academic and wider impact, the overlap between, for example, the two high-impact groups was not extensive (four case studies had both high academic and high wider impact).

To allow us to analyse each type of research – basic biomedical and clinical research – separately we took each type in turn and split those case studies into high, mid and low impact groups, as we had done with the complete set of case studies. On this occasion case studies were only ranked with case studies of the same type ie clinical case studies were only ranked with clinical case studies. Because of this the split points for high, mid and low groups were not always in the same place when all the case studies were considered together. This is illustrated in Figure 2.7.

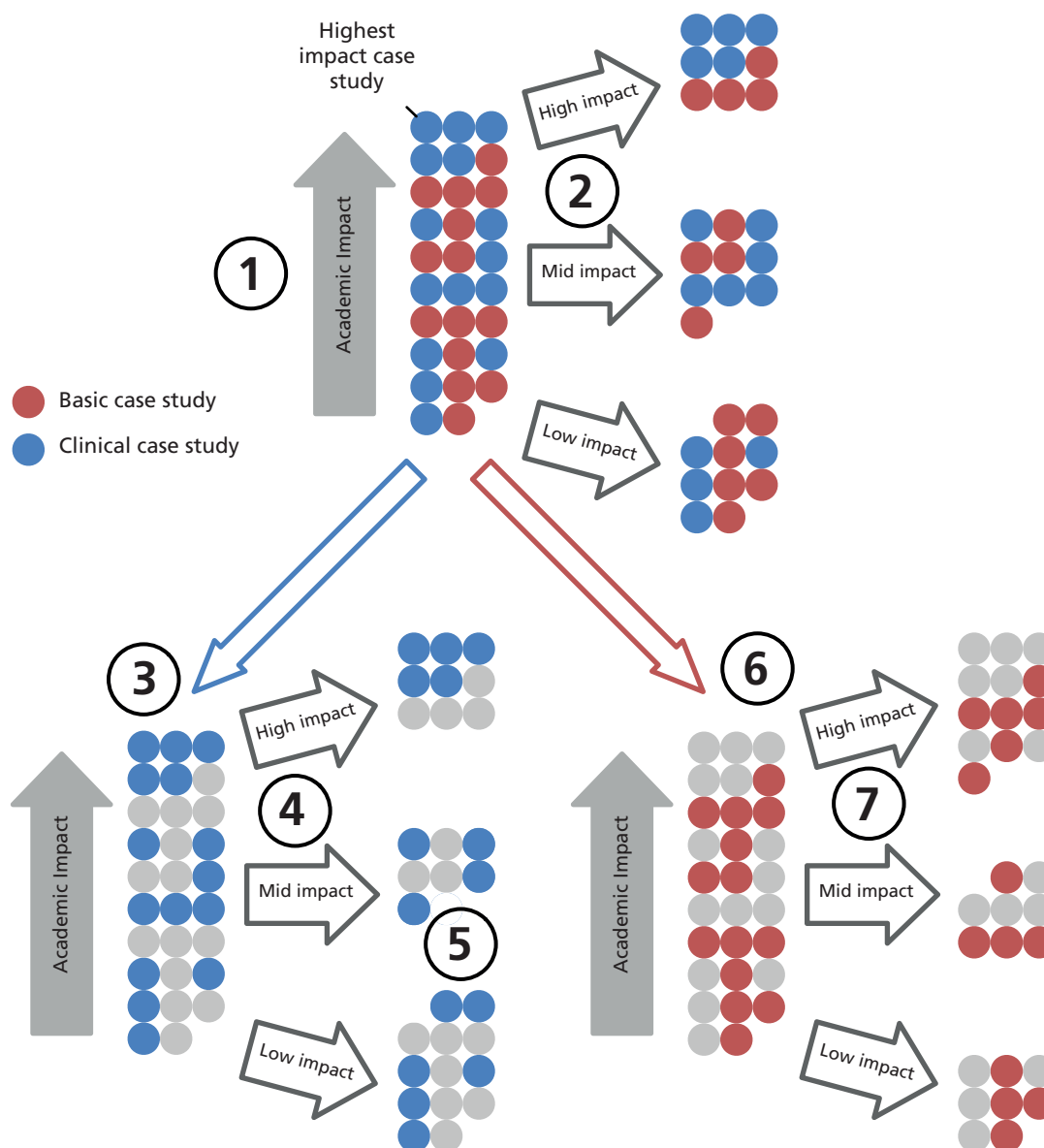
To identify factors associated with impact we examined the full case studies, coding the presence or absence of factors using NVivo, a qualitative analysis software package¹⁷. We identified an initial list of factors from our background knowledge and through discussions at the project and rating workshops. We also added factors that seemed of interest when we reviewed the case studies.

Figure 2.6
Payback categories and impact groupings



¹⁷ We used NVivo 8, which has now been updated; QSR International. *NVivo software*. http://www.qsrinternational.com/products_nvivo.aspx [Accessed 16 December 2010]

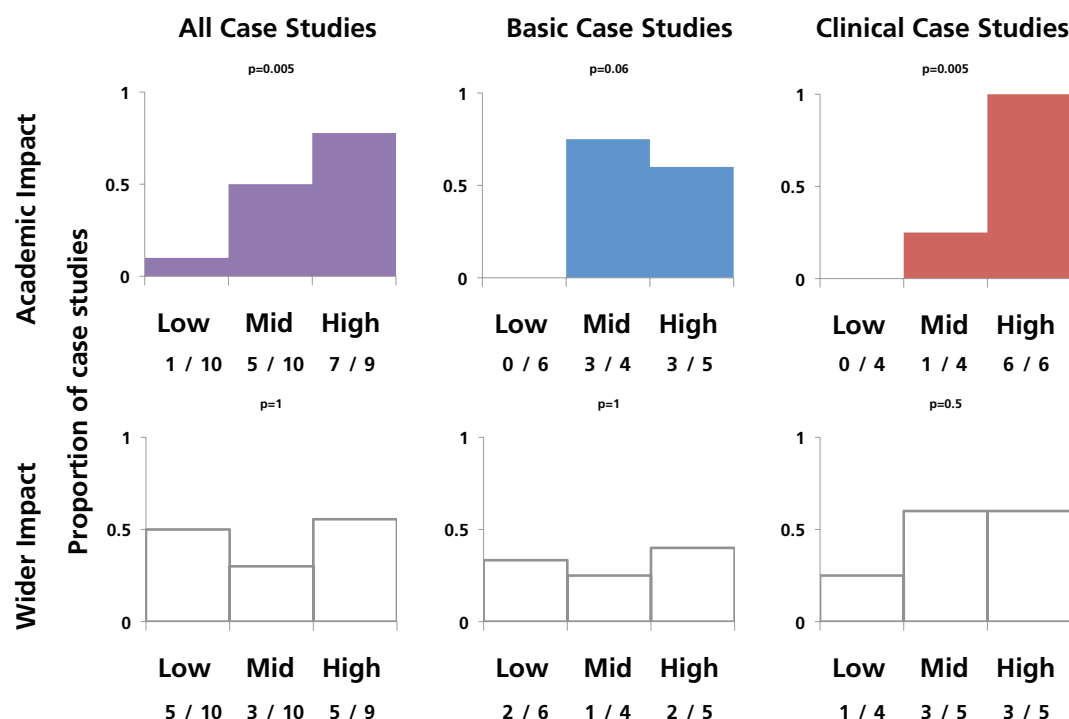
Figure 2.7
A diagrammatic overview of the analysis process to identify factors associated with impact



To prepare our groups of case studies for analysis to identify factors associated with academic impact: we first sorted all the case studies (basic and clinical together) in ascending order of academic impact (1) then split them into three roughly equal groups: high-impact, mid-impact and low-impact (2). See Methodology Report for exact details of splitting methodology.

To look in more detail at the characteristics of basic biomedical research we took only the basic case studies (3) (clinical case studies shown faded to grey) and split them into high-, mid- and low- impact groups (4). When we were considering only the basic case studies the low/mid split point fell in a slightly different place. This means two basic case studies are mid-impact when considering all the case studies but low-impact when considered with just the basic case studies (5). We then carried out a similar process for the clinical case studies by themselves (6&7) (basic case studies shown faded to grey). On this occasion both split points differed.

Figure 2.8
Example of graphs for factor of interest



We tackled the coding process by working initially with half of the case studies. Two members of the research team, working independently, took the high-impact cases and looked for common factors. They then compared notes to identify factors both had observed. Two further members of the research team did the same for the low-impact case studies. The research team then came together and all the factors were reviewed and clarified. We then addressed the cases that had not yet been examined, using the finalised list of factors, and revised the analysis of the initial cases in the light of the refined list. Finally, each factor was analysed quantitatively and qualitatively. To carry out the quantitative analysis, we looked at the balance of the factor's occurrence across high, mid and low academic and wider impact case studies. Having grouped the case studies into low-, mid- and high-impact groups for both academic and wider impact, and examined those groups for all case studies, and basic biomedical and clinical case study groups separately, we present the results for each factor of interest graphically using a standard six-panel layout of graphs; an example is shown in Figure 2.8. As explained earlier, because the com-

parison group changes when considering just basic biomedical or clinical case studies rather than all case studies, the split points between groups is not always the same. In other words the group of high-impact case studies for "all case studies" is not the combination of the high-impact basic biomedical and clinical case studies. Additionally, we used the Fisher Exact test to determine the likelihood of non-random associations between the variables. We selected the Fisher Exact test as it relies on fewer assumptions (normal distribution assumption is not needed) and is particularly useful for testing relationships in small samples (Cochran, 1954). Because of the small sample size, we did not use more complex methods such as an ordered logistic regression model and, in particular, we did not attempt to adjust for covariates. In each case, we show the data for each of the six panels, and as an indication of importance, shade the panels where the Fisher Exact p value is lower than or equal to 0.2 (to one significant figure). Because of the nature of our sample, we do not interpret the results in the standard way, as indicating a "significant" association, but instead as providing us with a relative indication of the likely robustness

of our associations. Because the randomisation in our sample is stratified we do not suggest that the figures are absolute measures or suggest that their exact value is interpreted – one reason for quoting them to only one significant figure.

For the qualitative analysis, we assigned each factor to a coder who reviewed all the occurrences of each theme to ensure consistency of interpretation. Resource limitations meant that we could not double-code cases, but by coding first by case study and then by factor we hope to have removed the majority of inconsistencies.

We presented our initial list of factors associated with impact at an Emerging Findings Workshop in London in April 2010, which was attended by collaboration members and a variety of policymakers and evaluators from cardiovascular and stroke research and wider health research, from the UK and overseas. The workshop highlighted a number of areas for further analysis and helped refine our thinking about the context of our work. Taking these suggestions into account and drawing on the contextual knowledge of the research team, we developed our observations into policy implications.

Chapter 3 Strengths and limitations of the methodology

Project Retrosight was not without some structural, methodological and scope limitations; however, while those must be acknowledged, we feel that they are balanced by the study's strengths.

Project Retrosight used more case studies than any other similar study we know of and selected them in a stratified random way designed to minimise biases and subjectivity. The 29 cases were structured using a comprehensive conceptual framework that helped ensure consistency across the full set and allowed for robust comparisons to be made. Case study quality was assured through review of the case studies by both the PI of the research project that formed the subject of each case study and two external subject experts. All were asked to assess the accuracy of the case study narratives and the impacts claimed.

Furthermore, the whole project was reviewed by two reviewers from outside the project team. Our international approach to the project brought strength in allowing us to consider a wider range of research contexts and to develop robust observations that are relevant internationally, but despite our best endeavours there are indications that we did not manage to fully standardise the case studies across the three countries.

The attribution of impact to specific research grants is an issue central to research evaluation, and while it is impossible to definitively allocate every impact to an individual piece of funding, we addressed this issue in Project Retrosight by attempting to quantify whether the case studies differed in the scope of the funding considered. We found that this bore no relationship to impact. The accuracy of the classification of our case studies was a second potential source of bias and so we examined the robustness of our findings by testing alternative definitions of our selection criteria. Finally, due to the challenges associated with estimating the impact of negative or null findings, we

also tested our observations on the full set of case studies with and without these grants included.

Number and selection of case studies

In case study research the challenge is to select a sample from which transferable findings can be developed, as the number of case studies available is limited. If the sample is small and selected at random, the results may be partial or incomplete. However, if the selection is too deliberate, there is a risk of biasing the findings of the study or limiting the conclusions that can be drawn from the data. It follows that there are two ways to address this challenge: using a larger sample and careful selection of cases. We used both approaches for Project Retrosight.

The number of cases used in Project Retrosight was substantially larger than in many previous projects of a similar nature, for example:

- sixteen cases in a study for the Arthritis Research Campaign (Wooding et al., 2005);
- eight cases in a study with the Irish Health Research Board (Nason et al., 2008);
- ten cases in a study conducted at the London School of Hygiene and Tropical Medicine (Kuruvilla et al., 2007).

We selected using a stratified random sample that retained a random element while ensuring balance across our three key characteristics: type of research, size of grant, and an estimate of impact level based on initial information from our PI survey.

We aimed to include examples of both high and low impact – a key strength of the study – by stratifying on the PIs' initial estimates of payback. In doing this, we have been able to demonstrate not only the presence of certain characteristics in high-impact research, but also their absence

in low-impact research. We do not know of any other studies that have taken such an approach.

Conceptual framework

The use of a consistent and comprehensive framework to structure case study material helped ensure that a range of case studies producing a diverse array of impacts could be reliably compared. The Payback Framework has been extensively used to measure research impact in a variety of contexts, both by the research team and other groups, and its use throughout the data collection, analysis and reporting of Project Retrosight has supported the study's clear focus and consistent structure.

The process of applying the Payback Framework and associated methods of data collection is also well established, providing a robust base from which to expand the scope of the project (for example, to low-impact case studies) and build innovative analysis. The Framework also supported the quantification of qualitative case study material through the rating process. This quantification allowed a more thorough and robust comparison of factors associated with impact than has previously been attempted.

External peer review

To ensure the accuracy of the case studies and to highlight any areas of concern, each case study was reviewed by the PI involved. To address issues of viewpoint, we identified two subject experts who also reviewed each case – one from the same country as the PI and one from a different country. This external review aimed to validate the case studies in the wider context of the cardiovascular and stroke research field, with reviewers focusing on the accuracy of the impacts attributed, the science described and the degree to which the PIs were reported to be leaders in their field. This is described in Table 2.1 on page 11 in more detail. We included a summary of the peer review comments with each published case study, and our rating panel was given the full set of comments. Ideally, we would have liked to integrate the comments into the case studies, but the project timelines meant this was not feasible.

The project as a whole was subject to peer review through RAND's Quality Assurance system. Reviewers were Tom Ling (RAND Europe) and

Chris Henshall (Brunel University and the University of York).

International approach

As far as we are aware, Project Retrosight is the first study to assess the impact of research across a number of countries using such a coordinated approach. This raised two concerns – we needed a consistent approach to case study authorship and our sample selection needed a similar balance of estimated high- and low-impact case studies for each country.

One of the aims Project Retrosight initially set out to explore was the extent to which factors associated with impact were consistent across countries. How likely was it that findings from one country could be generalised to others? The study found few differences between countries in the distribution of factors associated with impact. More ambitiously, we hoped to see if one particular country's methods were associated with impact. To do this we had to ensure the process of case study research in each country did not affect the apparent impact of the case. Unfortunately, although we expended considerable effort to ensure consistency across country teams, the design of the study made it impossible to show we had achieved this, and there are some indications that we had not.

Case study authorship

The concern for consistency in authorship was particularly acute because during case study research on payback a series of judgements had to be made about how to consider the scope of the work under examination, to ensure comprehensive description of impacts without exaggeration and to estimate the level of contribution made by the impacts identified.

To minimise the effect of these differences we had three international project meetings, regular conference calls and tuition to ensure the entire project team was involved in making such judgements. We also provided case study templates, interview protocols and project plans. The development of the individual case studies was an iterative process, which involved review of the draft case studies by the RAND/HERG team.

We then submitted all the cases to external peer review, and asked the reviewers how accurately the case study reported the impact of the

grant. The majority of these comments suggested our case studies were accurate; however, the balance of comments across the countries was markedly uneven (see Table 2.1 in Chapter 2). Ideally we would have been able to separate the effects of case study authorship and case study country to determine whether we had genuine differences between the countries; unfortunately, as the country and research teams were exactly aligned, this was not possible. This means we are unwilling to make conclusions based on differences between countries.

To ensure our more general observations were robust, we treated country as a confounder. To do this, we examined the distribution of each identified factor across countries. For two factors we found a distribution across countries that should be considered a caveat in interpreting our observations. We discuss this in more detail when we present each in Chapter 4.

Sample selection

To allow us sensibly to compare the average ratings by payback category across countries we needed to have a similar balance of case studies with estimated high and low impact in each country. Unfortunately, due to problems with the selection process and some refusals to participate, we did not achieve this. Australia in particular had a larger number of estimated high-impact case studies in the basic biomedical category than other countries.

As the differences between countries were relatively small, in our view they could have been accounted for by country, sample selection or authorship differences. This contributes to our reluctance to draw observations based on the differences between countries.

Attribution

The attribution of payback or impact to specific research grants or funders is an issue central to research evaluation. This issue was explored in some depth at a 1999 international workshop on research evaluation (Buxton et al., 1999; Croxson et al., 2001), where it was concluded that there are many complications in identifying the impact of specific funding.

In Project Retrosight, we attempted to assess the impact of 29 individual research grants. The Payback Framework and project protocols developed by the team provided guidance on the attri-

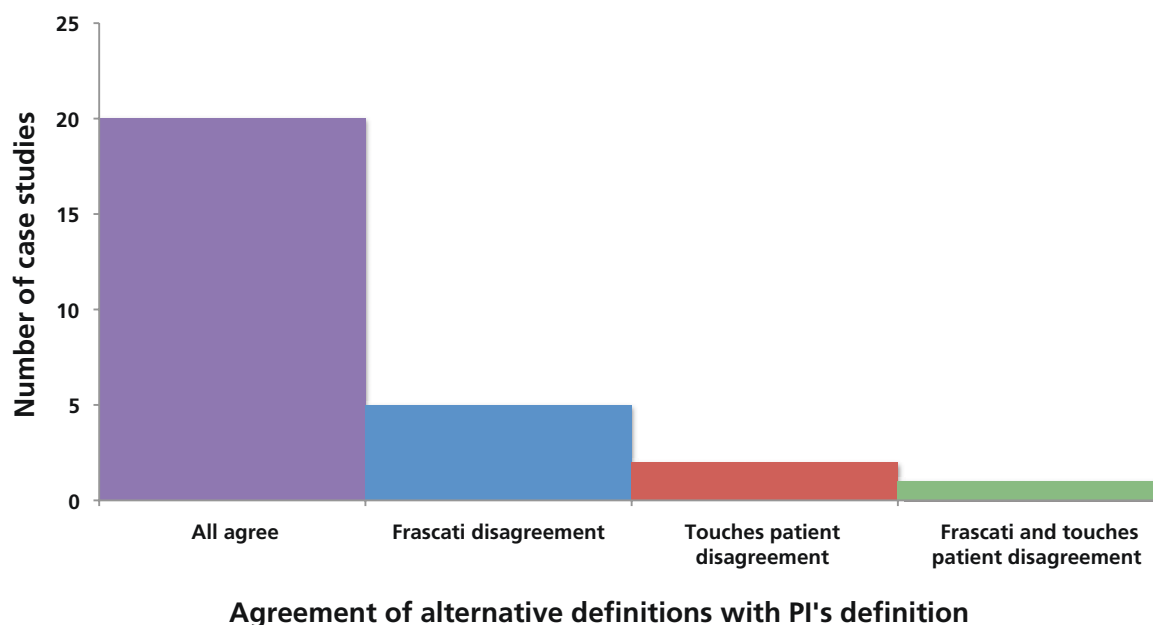
bution of publications (in particular) to the grant, while the independent peer review process provided some degree of validation for the range of impacts claimed.

There are two dimensions where assessments of attribution may be inaccurate – there may be inputs that we did not consider as part of the grant, and there may be payback or impacts to which other grants contributed. Despite our attempts to focus solely on one grant, there is a range of additional inputs to the research evaluated in the case studies. The key point to consider when addressing this is whether any of the benefits identified would have arisen without the specific grant in question. For this reason we analysed the scope of the work each case study encompassed – our concern was that case studies might report more payback because they extended beyond the case study grant. In essence, grants with more overlap would do better as they were getting the “credit” for the impact of a larger amount of research. To test whether this was so we classified the case studies according to the extent of overlap with other research done by the researcher before and concurrently with the case study grant (for details of this process see the accompanying Methodology Report, Pollitt et al., 2011a). We saw no relationship between the extent of overlap of the case studies and their academic or wider impact. This reassured us that scope was not a confounding factor.

Classification of the case studies

We attempted to stratify our sample of case studies across four dimensions – country of research, initial estimate of impact, type of research (basic biomedical or clinical), and size of grant. The first of these was easy to establish as all our funders provided funding only in their own country. The second was intended to ensure we included lower payback cases in our study sample and appears to have worked as planned. The classification by type of research was broadly successful, but is of such importance that we consider it in more detail below and treat it as a confounder. Finally, distinction according to grant size was abandoned because the range of sizes in our sample was small, differed between countries and was sometimes impossible to gauge from funder records. (For more details, see the accompanying Methodology Report, Pollitt et al., 2011a).

Figure 3.1
A comparison of the alternative research type definitions as applied to the case studies



Turning to the basic biomedical or clinical classification; although this distinction is almost universally accepted in the field of health, the exact border between the two can be very hard to determine. There is always likely to be some research that does not sit easily in either category, or which incorporates elements of both. We found that each of our funders had a slightly different way of distinguishing between basic biomedical and clinical research. Because of this we asked the PIs to classify their research according to the following hybrid of our funders' definitions:

- basic biomedical – focuses on normal or abnormal function at the molecular, cellular, organ or whole body level;
- clinical – focuses on patients, better diagnostics or treatments and increasing quality of life.

Because the basic biomedical/clinical distinction is not universally used, we wanted to test whether our observations would be robust against alternative definitions. We therefore tested the internationally recognised Frascati Manual classification published by the OECD¹⁸ and a more informal

definition of whether or not the research involved direct contact with patients. Two members of the research team applied these definitions. The results of the comparison (Figure 3.1) show a generally good agreement between the PIs' definitions and the Frascati Manual, and even closer agreement with the "touches patients" definition. Because of the importance of this distinction to our analysis we treated it as a confounder and examined the effect of "flipping" the case studies with least agreement between definitions on our observations. We discuss where "flipping" might change our observations in the section on the relevant association.

Estimating the impact of negative or null findings

We classified seven of our case studies as reporting negative or null findings. The concept of negative or null results has various definitions,¹⁹ but we use it to cover studies that fail to confirm or disprove a hypothesis, or disprove a hypothesis and preclude further work (for example, by demonstrating the

¹⁸ In order to test agreement with our basic biomedical/clinical definition we treated Frascati applied research as equivalent to clinical and Frascati basic research as equivalent to basic biomedical.

¹⁹ See the editorial guidelines of *Journal of Negative Results in Biomedicine* and *Journal of Negative Results (Ecology and Evolutionary Biology)*.

absence of a link between two systems). As we expected negative or null findings to be independent of other factors that might influence impact, we were concerned that a coincidental association between negative or null findings and a second factor could lead us to make inaccurate observations. We therefore tested the distribution of case studies with each factor associated with impact before and after excluding case studies with negative or null findings. We discuss the results of this analysis for each association in Chapter 4.

The available literature suggests that negative or null findings are less likely to be published than positive findings, which suggests they will be associated with lower impact (Gould, 1993). It is likely that our methodology will underestimate the impact of such studies as it will be harder to identify and evaluate an impact that causes something not to happen – an area of research that is not pursued, saving money for more productive research – than an impact that causes something observable to happen.

Chapter 4 Findings, observations and policy implications

In this chapter we describe each of the key findings or observations from our analysis and assess the nature of the evidence base for it in our study, and associated policy implications. We describe the findings in three subsections.

- **A large and diverse range of research impacts arose from the 29 case studies:** the evidence for these findings comes directly from the 29 studies of cardiovascular and stroke research grants.
- **The patterns and extent of impacts are very variable:** the analysis for these findings is based on the rating of the 29 case studies described in the previous chapter, and thus allows a more structured analysis than on the basis simply of the “raw” case study data.
- **Factors associated with impact:** our findings here are based on analysis of the relationship between the case study ratings and factors that may be relevant to impact, identified as described in Chapter 2.

A large and diverse range of impacts arise from the 29 case studies of cardiovascular and stroke research

We identified a large and diverse range of research impacts arising from the 29 case studies on cardiovascular and stroke research. The Payback Framework classifies research impact into five categories.

As illustrated in Tables 4.1, 4.2 and 4.3, the impacts of these 29 research grants captured in each of the five payback categories are diverse and far-reaching.

These findings resonate with the diversity of payback identified in an earlier study of the impacts from arthritis research (Wooding et al., 2004). It is

unlikely that the full extent of these impacts would have been identified without the structured case study approach employed in both studies.

The nature of the distribution of broader economic benefits (the fifth payback category) is discussed on page 27. But it is important to note here that the definition of broader economic benefits used in this study, and as described in the three country tables, relates to the commercial development and uptake of products informed by the research findings; and the human capital approach, that is, considering the benefits from a healthy workforce in terms of the value of lost production avoided as a result of reductions in mortality and morbidity. We do not include in this category the value to the economy of the PhD training provided nor the intrinsic value of health benefits, although these too can be seen as economic benefits (HERG et al., 2008).

The patterns and extent of impacts are very variable

In addition to cataloguing the diversity of impact, it is also apparent that the pattern of impacts is very variable. We now describe three aspects of this variation.

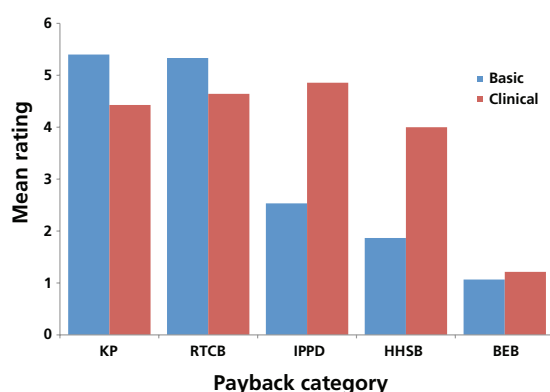
There are variations between the impacts derived from basic biomedical and clinical research

As Figure 4.1 shows, there are differences in the impact of basic biomedical and clinical research. For the two academic impact categories – “knowledge production” and “research targeting and capacity building” – all the case studies were rated at least 1 for impact (with raters having the option to rate 0 if there was no impact); however, the average rating was higher in basic biomedical research than in clinical research.

Table 4.1
Selected impacts from eight projects funded by the National Heart Foundation of Australia

Payback category	Total contribution and examples
<i>Knowledge production:</i> peer-reviewed publications.	<ul style="list-style-type: none"> All Australian projects (five initially estimated to be high impact, three initially estimated to be low impact) produced peer-reviewed publications. A project on immunoelectron microscopy of amine and peptide synapses on sympathetic preganglionic neurons resulted in 18 articles that have received a total of 780 citations.
<i>Research targeting and capacity building:</i> post-graduate research training; career development of PI and team; transfer of skills; informing future studies.	<ul style="list-style-type: none"> All Australian projects (five initially estimated to be high impact, three initially estimated to be low impact) contributed to this category. A project on high density lipoprotein (HDL) led to a large number of collaborations for the PI and advanced the career of the post-doc; it also resulted in new research techniques, further research funding for the group and better targeting of other groups through increased understanding of HDL. A follow-up study of heart attack patients trained PhD students; expanded population data for future studies.
<i>Informing policy and product development:</i> informing a wide range of policies, including clinical guidelines; informing the development of therapeutic products, diagnostic tests, etc.	<ul style="list-style-type: none"> All Australian projects (five initially estimated to be high impact, three initially estimated to be low impact) contributed to this category. A project that created animal models for myocardial dysfunction had contributed to the decision to create a transgenic facility at the research institute, which later informed the development of a commercial facility. Research on the secondary prevention of hypertension was cited in two clinical guidelines.
<i>Health and health sector benefits:</i> health gains from improved treatments and public health; more effective use of healthcare resources; increased health equity.	<ul style="list-style-type: none"> All Australian projects (five initially estimated to be high impact, three initially estimated to be low impact) contributed to this category. A project studying the effects of angiotensin converting enzyme (ACE) inhibitors had provided part of the international literature used to justify their adoption in the treatment of LV hypertrophy, hypertension, cardiac disease, etc; there have been major health gains from the introduction of ACE inhibitors. A project studying the follow-up to heart attacks contributed to a major international project on health promotion, which in turn contributed to a decline in coronary heart disease in the Hunter region.
<i>Broader economic benefits:</i> benefits to the economy such as greater employment, exports, etc., as a result of commercial development informed by the research; contribution to a healthier workforce through a reduction in production lost by mortality and morbidity.	<ul style="list-style-type: none"> Five of the eight Australian projects contributed to this category, of which four were initially estimated to be high impact, and one was initially estimated to be low impact. The commercial transgenic facility developed as a result of the animal models for myocardial dysfunction is now a multi-million-dollar business that exports 80% of its services. A project on the effects of lean meat diets on plasma lipids and haemostatic function might have contributed to a larger body of work that, in turn, might have contributed to identifying the health benefits of lean meat and benefits for the meat industry (a higher value market for lean meat).

Figure 4.1
Mean impact rating by payback category and type of research



For the three wider impact categories the pattern was reversed. For the payback category “informing policy and product development” over one third (6 of 15) of the case studies on basic biomedical research were rated 0, compared to no clinical case studies. In the “health and health sector benefits” category, 8 of 15 basic biomedical case studies rated 0 compared to 2 of 14 clinical projects. Finally, 11 of 15 basic biomedical projects were rated 0 or more for “broader economic benefit” compared to 8 of 14 clinical projects – although it should be noted that the case study rated highest in this category was a basic biomedical project. When the three elements of wider impact were combined, all clinical

Table 4.2

Selected impacts from 12 projects funded by the Heart and Stroke Foundation of Canada and the Canadian Institutes of Health Research

Payback category	Total contribution and examples
<i>Knowledge production:</i> peer-reviewed publications.	<ul style="list-style-type: none"> All Canadian projects (six initially estimated to be high impact, six initially estimated to be low impact) produced peer-reviewed publications. A project on the genetic and cellular determinants of increased growth of vascular smooth muscle in spontaneously hypertensive rats produced a series of journal articles. Sixteen articles produced 849 citations and included a paper in the highly prestigious <i>Journal of Clinical Investigation</i>.
<i>Research targeting and capacity building:</i> post-graduate research training; career development of PI and team; transfer of skills; informing future studies.	<ul style="list-style-type: none"> All Canadian projects (six initially estimated to be high impact, six initially estimated to be low impact) contributed to this category. A project on the effects of simulated stroke on developing astrocytes resulted in two PhDs; techniques were taught to students and visiting researchers. A project on low-intensity warfarin and thrombosis resulted in one MSc, refinement of assays, and informed some major follow-on projects.
<i>Informing policy and product development:</i> informing a wide range of policies, including clinical guidelines; informing the development of therapeutic products, diagnostic tests, etc.	<ul style="list-style-type: none"> Eleven of the 12 Canadian projects contributed to this category, of which five were initially estimated to be high impact and six were initially estimated to be low impact. Guidelines recommend a treatment pathway for antiphospholipid antibodies (APLA) based on the original warfarin-based project (described above); work on the follow-on studies is cited in guidelines for warfarin therapy. A project on prolonged heart and lung allograft preservation was part of a much larger body of research referenced in guidelines and contributing to working with industry.
<i>Health and health sector benefits:</i> health gains from improved treatments and public health; more effective use of healthcare resources; increased health equity.	<ul style="list-style-type: none"> Seven of the 12 Canadian projects contributed to this category, of which four were initially estimated to be high impact and three were initially estimated to be low impact. The treatment path for APLA patients is much improved, leading to some health gain. A project on nimodipine binding in cerebral ischemia was part of a stream of work included in the Canadian Best Practice Recommendations for Stroke. This study, along with many others, has led to health gains and cost savings through the administration of tissue plasminogen activator.
<i>Broader economic benefits:</i> benefits to the economy such as greater employment, exports, etc., as a result of commercial development informed by the research; contribution to a healthier workforce through a reduction in production lost by mortality and morbidity.	<ul style="list-style-type: none"> Two of the 12 Canadian projects contributed to this category, of which one was initially estimated to be high impact and one was initially estimated to be low impact. A project on cell–cell interactions in the disposition of natriuretic peptides in bovine chromaffin cells used a radioimmunoassay the PI had created previously. It helped lead to kits now sold by a commercial company. A project on coronary lesions and vasoactivity in salmon led on to a body of work that contributed to the literature showing farmed salmon are a safe source of human dietary omega-3 input, thus contributing to sustainable aquaculture.

case studies had some wider impact (i.e., a rating of at least 1 in one of the three wider impact payback categories) compared to only 6 of 15 of the basic biomedical case studies.

These results suggest that basic biomedical research has a greater academic impact and clinical research has a greater wider impact. This observation needs to be interpreted with care, given the time lags involved in realising payback in the wider impact categories. Although data on how long it takes to translate bodies of research from bench to bedside are relatively sparse, 17 years is commonly cited (Balas and Boren, 2000; Grant et al., 2000; HERG et al., 2008; Morris et al., forth-

coming). For Project Retrosight, the time between the research project period (1989–93) and the fieldwork for the case studies (2008–9) was 15–20 years. In other words, a full or partial explanation for the difference found in the current study in wider impacts for basic biomedical and clinical research could be that clinical research is further downstream than basic biomedical research and thus has a greater opportunity to realise impacts in the timescales considered in this project. Both basic biomedical and clinical research produce a wide range of benefits, but within a time period of 15–20 years it is likely that basic biomedical research will produce more of the traditional

Table 4.3
Selected impacts from nine projects funded by the British Heart Foundation and the Stroke Association

Payback category	Total contribution and examples
<i>Knowledge production:</i> peer-reviewed publications.	<ul style="list-style-type: none"> All UK projects (four initially estimated to be high impact, five initially estimated to be low impact) produced peer-reviewed publications. A project on the role of coagulation and fibrinolysis in the pathogenesis of recurrent stroke led to a series of articles, seven of which have been cited 393 times in total.
<i>Research targeting and capacity building:</i> post-graduate research training; career development of PI and team; transfer of skills; informing future studies.	<ul style="list-style-type: none"> All UK projects (four initially estimated to be high impact, five initially estimated to be low impact) contributed to this category. The project (above) led to two PhDs, an MD and development of a patient cohort and control group that formed the basis of a stream of work. It helped the PI establish his research group. A project on lipoprotein production led to a PhD and new molecular biology equipment and techniques in the lab, which produced a significant change in research direction.
<i>Informing policy and product development:</i> informing a wide range of policies, including clinical guidelines; informing the development of therapeutic products, diagnostic tests, etc.	<ul style="list-style-type: none"> Four of the nine UK projects contributed to this category, of which two were initially estimated to be high impact and two were initially estimated to be low impact. A project on stroke prevention in the elderly in primary care informed guidelines in a working group statement and protocols of local units in the health service. A project on the incidence, severity and recovery of language disorders following right-hemisphere stroke has been cited in the national guidelines, informed curriculum development of a speech therapy school and informed a patient leaflet.
<i>Health and health sector benefits:</i> health gains from improved treatments and public health; more effective use of healthcare resources; increased health equity.	<ul style="list-style-type: none"> Four of the nine UK projects contributed to this category, of which two were initially estimated to be high impact and two were initially estimated to be low impact. A project analysing the results of the Heartstart Scotland initiative to introduce automated defibrillators into all Scotland's ambulances is widely cited in guidelines and informed policy of ambulance services in Scotland and England. As a result it has made an important contribution to the increased survival rate following out-of-hospital cardiac arrest. A project on fibrillin deficiency in Marfan syndrome has contributed to international research that improved diagnostic tests and informs preventive management that has pushed the average age of death higher; also, health gain from reassuring family members who do not have the mutation.
<i>Broader economic benefits:</i> benefits to the economy such as greater employment, exports, etc., as a result of commercial development informed by the research; contribution to a healthier workforce through a reduction in production lost by mortality and morbidity.	<ul style="list-style-type: none"> Three of the nine UK projects contributed to this category, of which two were initially estimated to be high impact and one was initially estimated to be low impact. The project on automated defibrillators has led to increased survival rates from cardiac arrest and it is possible that a few people have been able to return to work who might not otherwise have done so. The increased life expectancy of patients with Marfan syndrome has mostly been among people of working age; therefore a number of people have been able to remain active in the workforce.

academic impacts, and clinical research will produce more wider impacts on health policy, health gain and broader economic benefits. This suggests that funding bodies could prioritise basic biomedical or clinical research based on the type of research impact they wish to achieve and the timescale over which they wish to achieve it.

There is no correlation between knowledge production and wider impacts

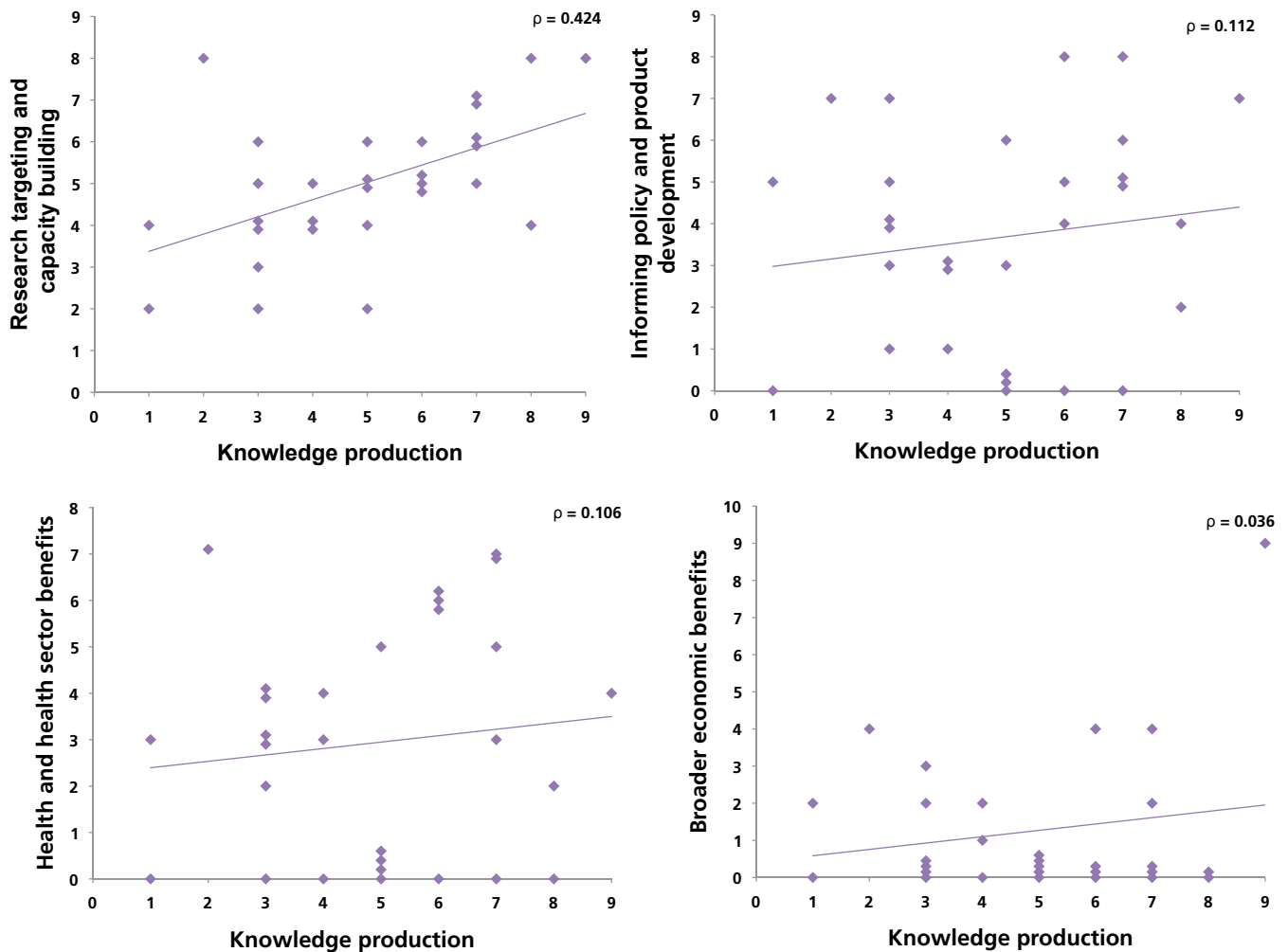
A further finding on the nature of impact is the lack of correlation between knowledge production and

the three payback categories associated with wider impacts (Figure 4.2). As already noted (see Deriving impact categories section on page 12), there is some correlation between knowledge production and research targeting and capacity building.

Here it is important to remember our earlier caveat about different types of research having different impact profiles, and the time lags often involved before wider impacts arise. Nevertheless, from a policy perspective this finding would suggest that wider impacts are not necessarily predicated on knowledge production and that research

Figure 4.2

Correlations between knowledge production and other payback categories. Note that we have slightly offset overlapping points, on the vertical axis, so the number of points in any one place can be seen. The actual values are all integers.



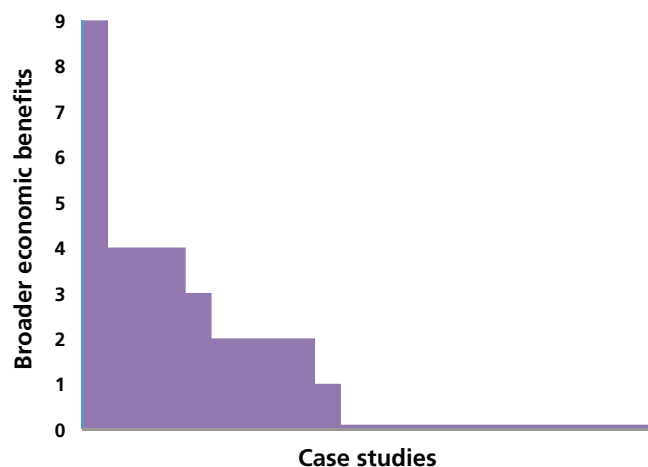
funding agencies wishing to maximise wider impacts should use broader selection criteria, rather than relying solely on those associated with trying to maximise knowledge production.

The majority of economic impacts identified come from a minority of projects

A further important finding relates to broader economic impacts (as defined above). Only a small number of case studies (4 of 29) showed that the projects produced broader economic benefits rated 4 or above (Figure 4.3). This means that the majority of the economic impacts identified came from a minority of projects. That small proportion can, however, produce impacts of a very signifi-

Figure 4.3

Distribution of broader economic impacts



cant value – and we know from previous research that the value of the impacts of programmes of research assessed significantly outweigh the costs, resulting in a very attractive return on investment (HERG et al., 2008).

As noted above, the definition of broader economic benefits we use here is rather restrictive, but nevertheless it is interesting to note that the distribution for broader economic benefit is highly skewed. Such a skewed distribution is similar to those observed in empirical studies of the productivity of authors, and output and citations of papers (Erar, 2002). These distributions tend to follow the 80:20 rule where, for example, 80% of citations come from 20% of papers. From a policy viewpoint it is important that these distributional effects are understood and acknowledged in any assessment and discussion of research impact, especially when it could influence the allocation of research funds.

Factors associated with impact

As stated earlier, a challenge for research funders and policy makers is to identify factors that are associated with high or low impact and could be used to inform policy and funding decisions. In this section we identify a number of factors in cardiovascular and stroke research that are associated with higher and lower academic and wider impacts. These factors provide some evidence of the characteristics of the research projects most likely to create substantial impact. Table 4.4 provides an overview of all 29 case studies, showing which impact groups they belong to and the factors associated with impact identified in each.

Because our observations are based on a relatively small number of cases, especially when disaggregated into various groups for analysis, we always quote actual numbers of case studies for numerators and denominators, e.g. 2/3 for 2 out of 3, to avoid any impression of spurious precision or generalisation. For each of the factors being assessed we illustrate the associations through a standard set of figures, with six histograms capturing the relationship between high-, mid- and low-impact case studies by the type of research (all research, basic biomedical and clinical) and the type of impact (academic and wider). As discussed in Chapter 2, ranking all the case studies differs from ranking the basic biomedical or clinical case studies sepa-

ately, therefore the cut points between the high, mid and low groups differ. In other words a clinical case study that is mid academic impact when all the case studies are considered may be high academic impact when only clinical case studies are considered. The shaded histograms (Figures 4.4–4.14) show associations that are discussed in the text: blue shading represents associations found in basic research, red represents clinical research and purple shading is used where an association is found irrespective of the type of research. As discussed earlier, we used the Fisher Exact test to determine whether there are non-random associations between the variables and interpret the results as providing us with a relative indication of the likely robustness of our associations (we treat them as indicative because of the small sample size and stratified nature of our selection). As the *p*-numbers illustrate, with just 29 case studies to start with, and each factor based on analysis of the subset of the 29, some of the differences described could have arisen by chance or as a result of a correlated but quite different factor: our observations should be considered with that caveat in mind.

1. Basic biomedical research with a clear clinical motivation is associated with high academic and wider impacts

The definition used for this observation was that clinically motivated basic biomedical research occurs when there is evidence in the case study that the research team has a clearly articulated clinical endpoint and/or is explicit in the case study about their clinical motivation. How far the motivational issue overlaps with the PI being a clinician is discussed below, with examples (Figure 4.4). We observed that clinically motivated basic biomedical research is associated with higher impacts. All high academic (5/5) and wider (5/5) impact case studies on basic biomedical research demonstrated a clinical motivation, compared to 2/6 low academic impact case studies, and 3/6 for low wider impact.

For the five high academic and wider impact case studies on basic biomedical research, three of the researchers had a clinical qualification, although they describe their research as being basic biomedical; this is confirmed in our sensitivity analysis of the basic biomedical–clinical research definitions in Chapter 2. In such cases motivation can be explained by the researchers’

Table 4.4

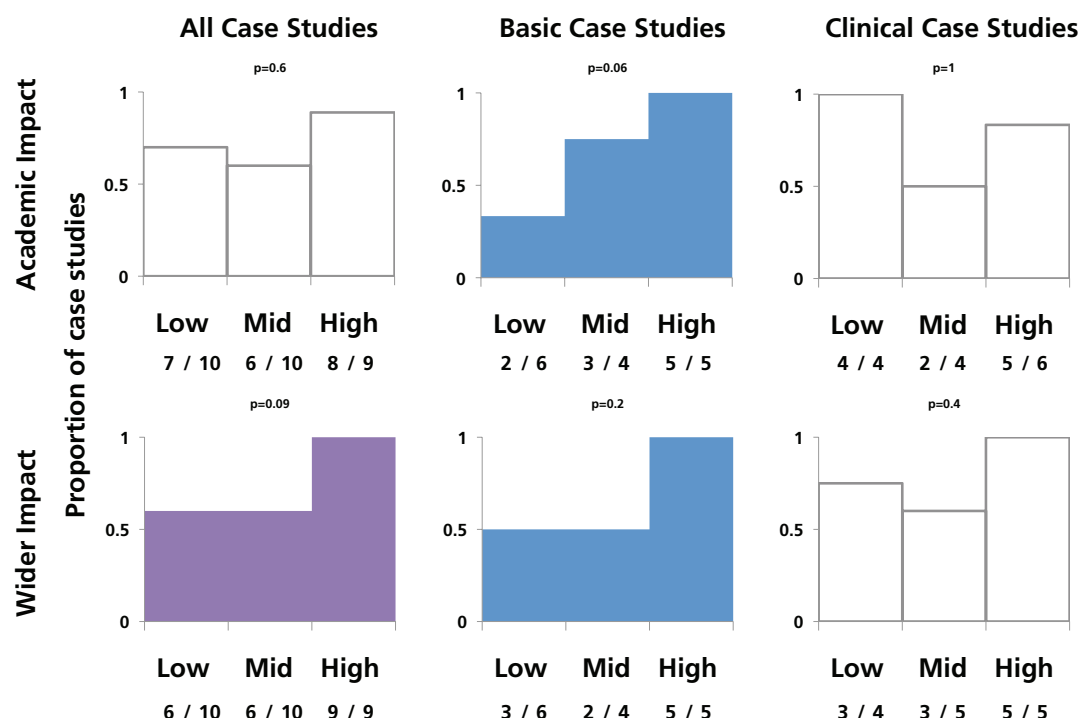
Overview of the 29 case studies indicating impact groups and factors associated with impact identified in each

		Impact level						Factors associated with impact										
		Academic impact			Wider impact			Clinical motivation	Co-location	Strategic thinking	Collaboration (general)	International collaboration			Engagement with practitioners & patients	Collaboration with industry	Negative findings	Initial rejection
		All case studies	Basic case studies	Clinical case studies	All case studies	Basic case studies	Clinical case studies					General	Facilitates research	Facilitates impact				
Australia	1																	
	2																	
	3																	
	4																	
	5																	
	6																	
	7																	
	8																	
Canada	1																	
	2																	
	3																	
	4																	
	5																	
	6																	
	7																	
	8																	
	9																	
	10																	
	11																	
	12																	
UK	1																	
	2																	
	3																	
	4																	
	5																	
	6																	
	7																	
	8																	
	9																	

Key

	High impact
	Mid impact
	Low impact
	Factor present in case study
	Not applicable

Figure 4.4
Clinical motivation



clinical background, as remarked by a number of the principal investigators:

“The product you see is not just a clinician; it is a clinician with a strong background in the laboratory.”

“I am not a basic science driven person, driven by the knowledge of basic science; I am driven by an application at the end of the day that has a bottom line in terms of clinical practice.”

Policy implication: When seeking to achieve high academic and wider impacts, encourage and support clinically motivated basic biomedical research.

2. Co-location of basic biomedical research in a clinical setting is associated with high wider impact

We considered co-location of basic research in a clinical setting to have occurred when basic research projects were undertaken in a hospital or similar setting. As shown in Figure 4.5, the majority (4/5) of high wider impact case studies

on basic biomedical research were conducted in a clinical setting, compared to 2/6 low-impact case studies (and 2/4 mid-impact case studies). Two PIs explicitly expressed this point in their case studies:

“One of the great things about being here has always been that if you wanted to do something clinical the people are right here ... So they are willing to talk to you ... And they are interested in doing research and collaborating.”

“To work in isolation is extraordinarily difficult. You just cannot overestimate the value of those casual conversations in the coffee room, the formal weekly meetings, where you justify your position and the progress you are making. And the opportunity for informal collaboration ...”

By contrast, the same does not apply for academic impact for basic biomedical research or for academic or wider impact for clinical research association. There might be several possible reasons for this. We could deduce that co-location can stimulate demand for basic biomedical research within

Figure 4.5
Co-location of research

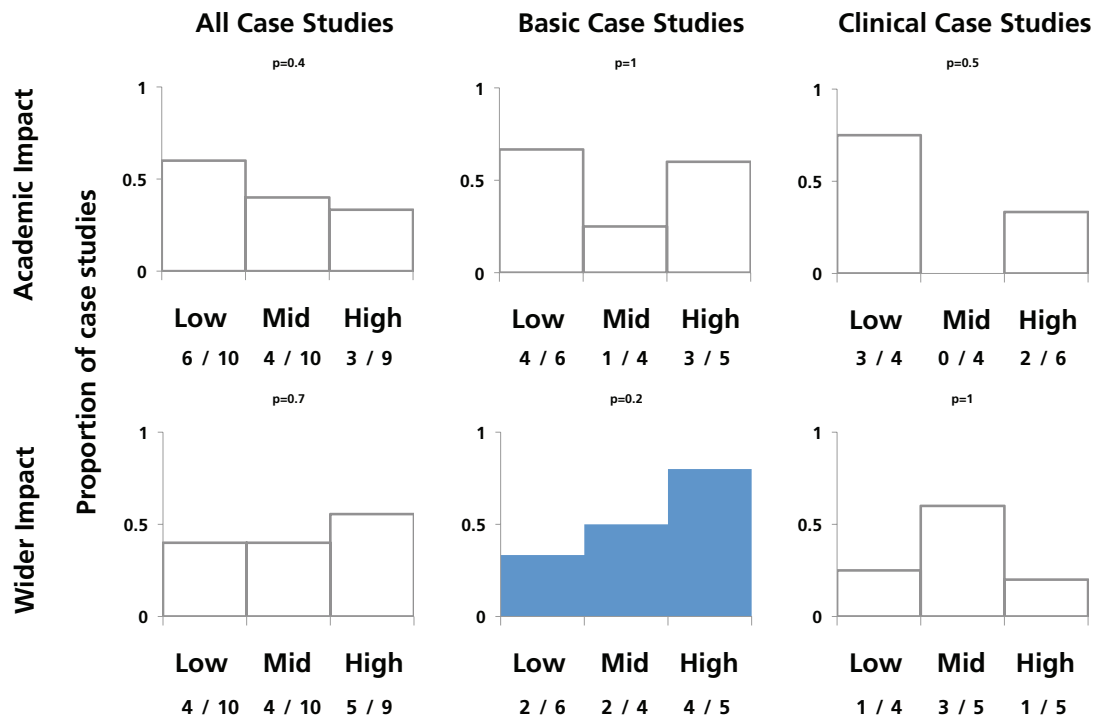


Figure 4.6
Overlap of clinical motivation and co-location

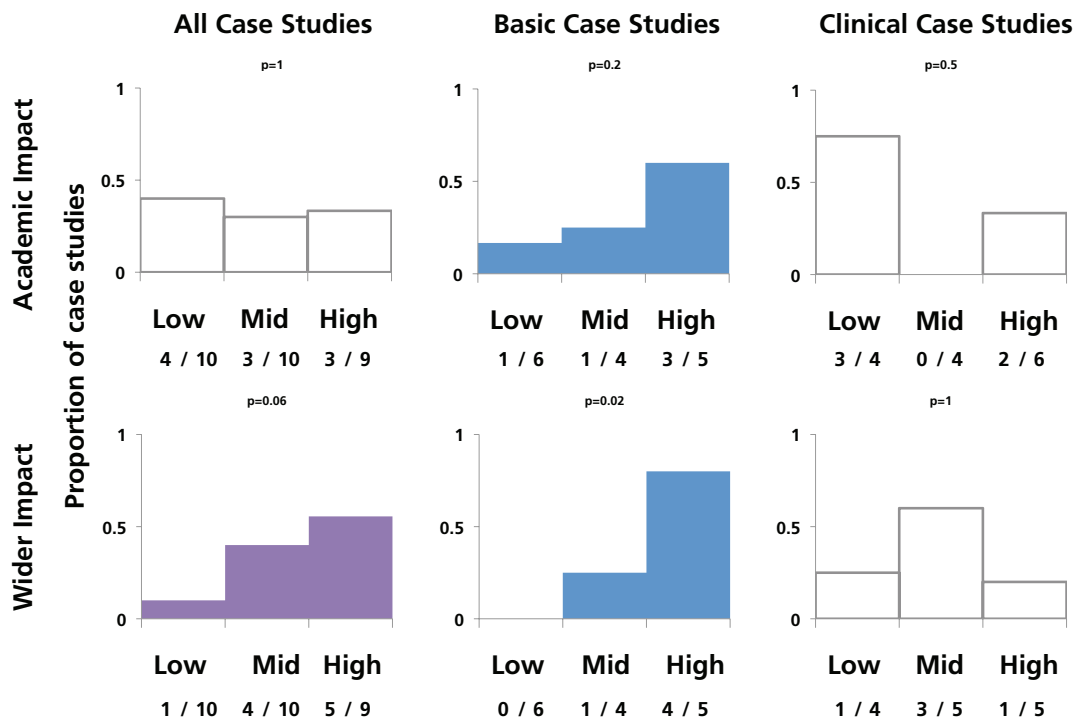
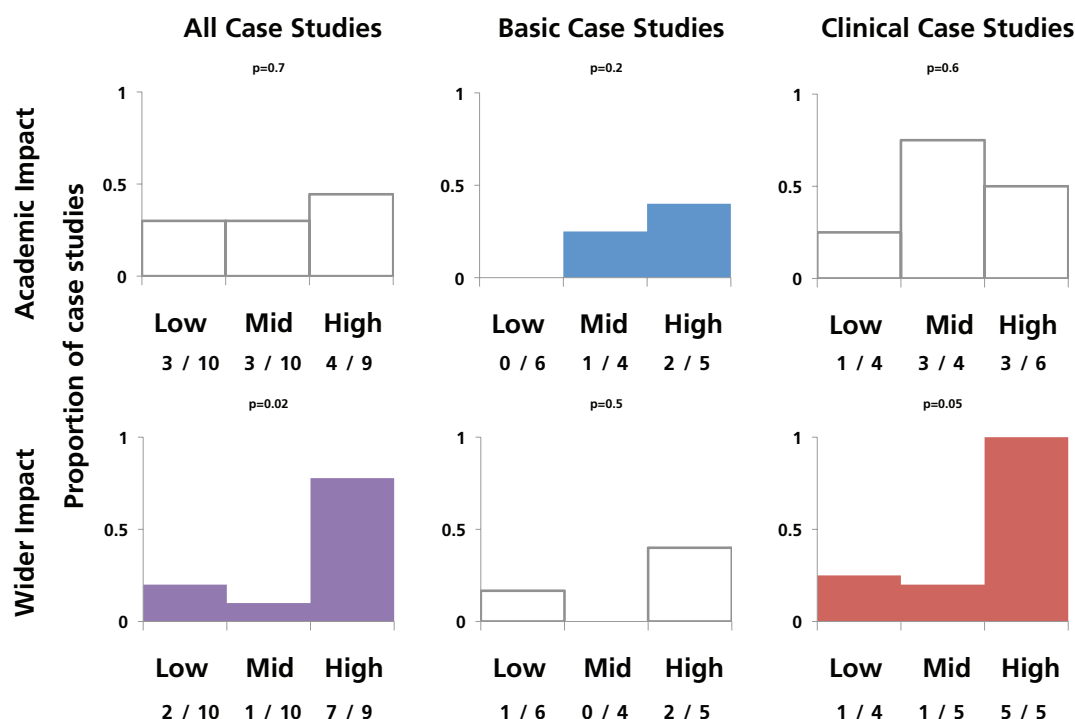


Figure 4.7
Strategic thinking



the clinical sector; or perhaps the clinical location helps create a clinical motivation. Seen from the perspective of the would-be funder, this suggests that co-location is only really beneficial when the aim is to translate basic biomedical research into wider impacts.

We also investigated the overlap between clinical motivation of basic biomedical research *and* co-location of basic biomedical research in a clinical setting (Figure 4.6). Interestingly this overlap only occurred for high-impact case studies. Four out of five high wider impact case studies on basic biomedical research demonstrated a clinical motivation and were conducted in a clinical setting, compared to no low-impact case studies. This would suggest that the two factors act synergistically, although this observation clearly warrants further research.

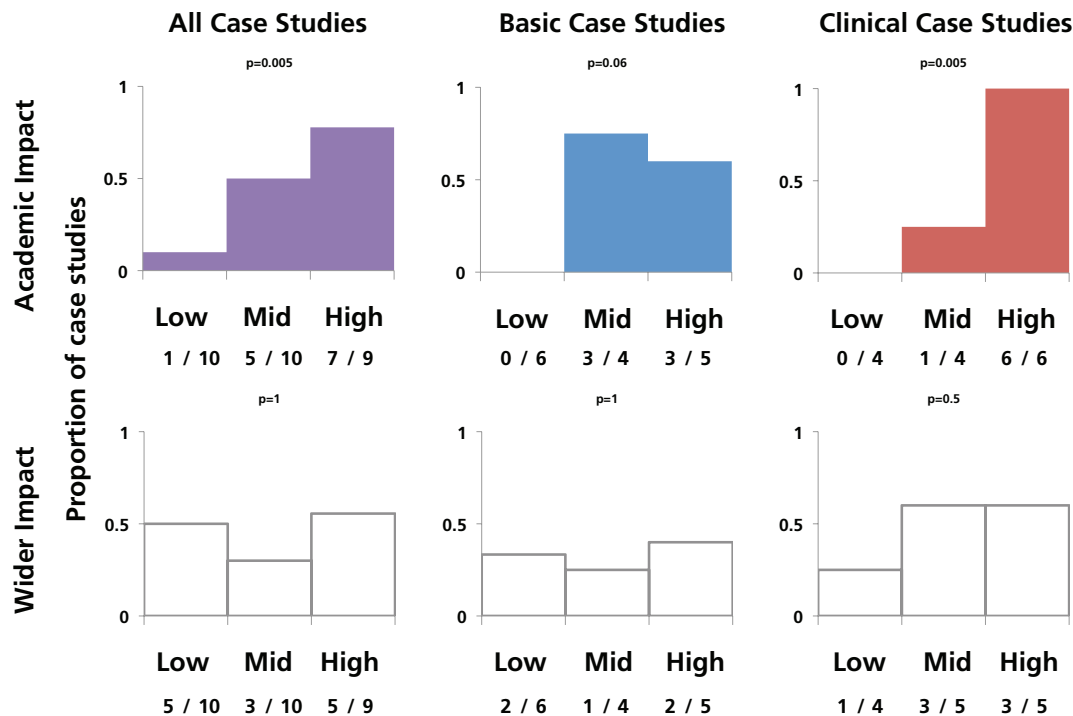
Policy implication: When seeking to achieve high wider impacts from basic biomedical research, encourage and support the co-location of basic biomedical researchers with clinicians in a clinical setting (e.g. a teaching hospital or health organisation)

3. Strategic thinking by clinical researchers is associated with high wider impact

For the purposes of this study, we define strategic thinking as the process of thinking used by clinicians when there was evidence in the case study that the research team had thought through the pathways by which research could potentially be translated into practice. There is some evidence that the thinking through the translation and application of clinical research is associated with wider impact. All (5/5) high wider impact case studies on clinical research had evidence of strategic thinking by the PI, compared to 1/4 low-impact case studies (Figure 4.7).

From a policy perspective, these data suggest there are benefits when clinical research is undertaken by those able and willing to think about its potential translation into clinical practice. This may have relevance to initiatives to include discussion of potential translation in research applications, although it is not clear from our data whether encouraging other researchers to think through translation would have the same effects.

Figure 4.8
Research collaboration



Policy implication: When seeking to achieve high wider impacts from clinical research, focus clinical research funding on PIs or teams who think strategically about translation into clinical practice.

4. Research collaboration is associated with high academic and wider impact

Collaboration is often seen as an important factor for success in scientific research but it can take many different forms and operate at a range of levels. It can involve collaboration within the national research system, with international colleagues, industrial partners, policy makers, practitioners or even patients themselves. These overlap in various ways, but as far as possible we concentrate here on collaboration by researchers within the research system, while considering other types of collaboration.

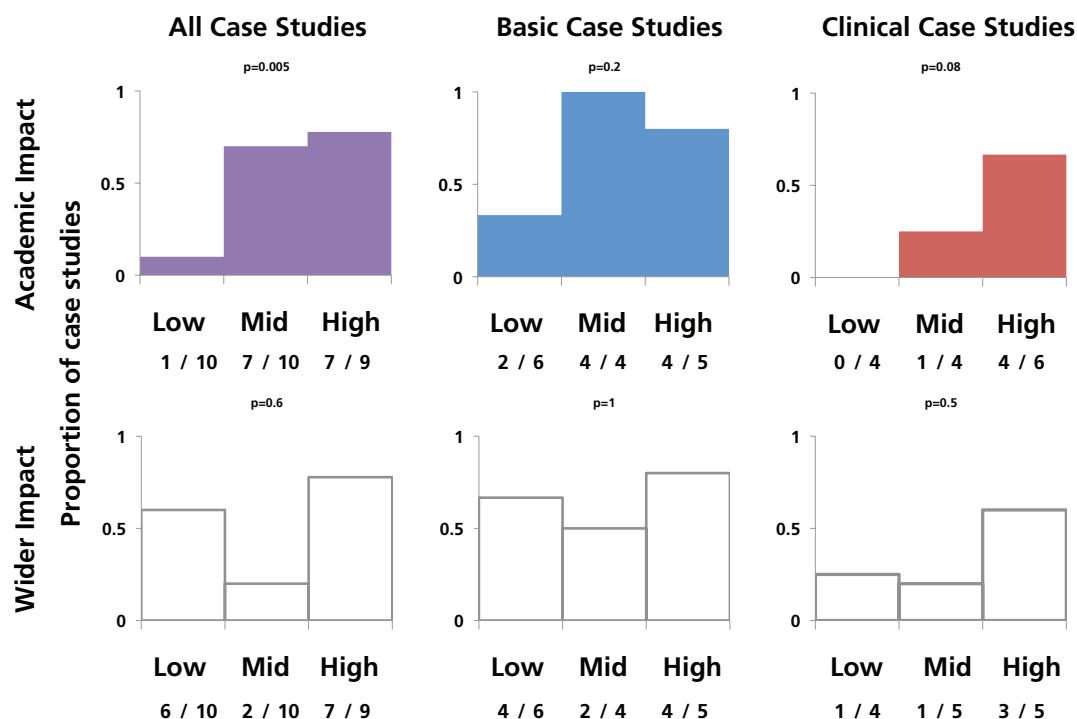
We defined collaboration as activities that involved both project team researchers and other researchers outside that group. We separated out three types of collaboration – resource-based (where researchers shared reagents, equipment or other research infrastructure); design-based

(where researchers outside the group contributed to the design of the study); and other (types of collaboration not captured in the first two categories). We examined the case studies for examples of collaboration and ways in which it occurred in each of these three areas.

Our analysis revealed that collaboration is never strongly associated with low impact, although the association with high impact varies from strong to none at all (Figure 4.8). The majority of high academic impact case studies (7/9) involve some type of collaboration, compared to 1/10 low-impact cases. The most common form of collaboration is resource-based – observed in 20/29 of the cases – and only two are with non-researchers, a fish hatchery and a care provider. However, of all the examples of collaboration in our case studies, only resource-based collaborations produced negative results; if these are excluded, the association of high impact with collaboration increases.

We found that collaboration is common in both clinical and basic biomedical case studies but that the association of collaboration with high

Figure 4.9
International collaboration



academic impact is much stronger in clinical cases than in basic biomedical research. When case studies that produced negative results were excluded from the sample, this relationship between academic impact and collaboration in clinical research was weaker because all the low-impact cases had been removed. Nevertheless, there remained sufficient disparity between the high-impact cases and the mid-impact cases to support the association between high academic impact and collaboration.

The link between collaboration and high impact is robust enough to stand up to reclassification of the case studies; when a disputed basic biomedical case study was reclassified as clinical, it strengthened the relationship with academic impact. Conversely, when a disputed clinical case was reclassified as basic biomedical, the relationship was weakened, but was still evident.

Policy implication: When seeking to achieve high academic and wider impacts, encourage and support research collaboration for both basic biomedical and clinical research.

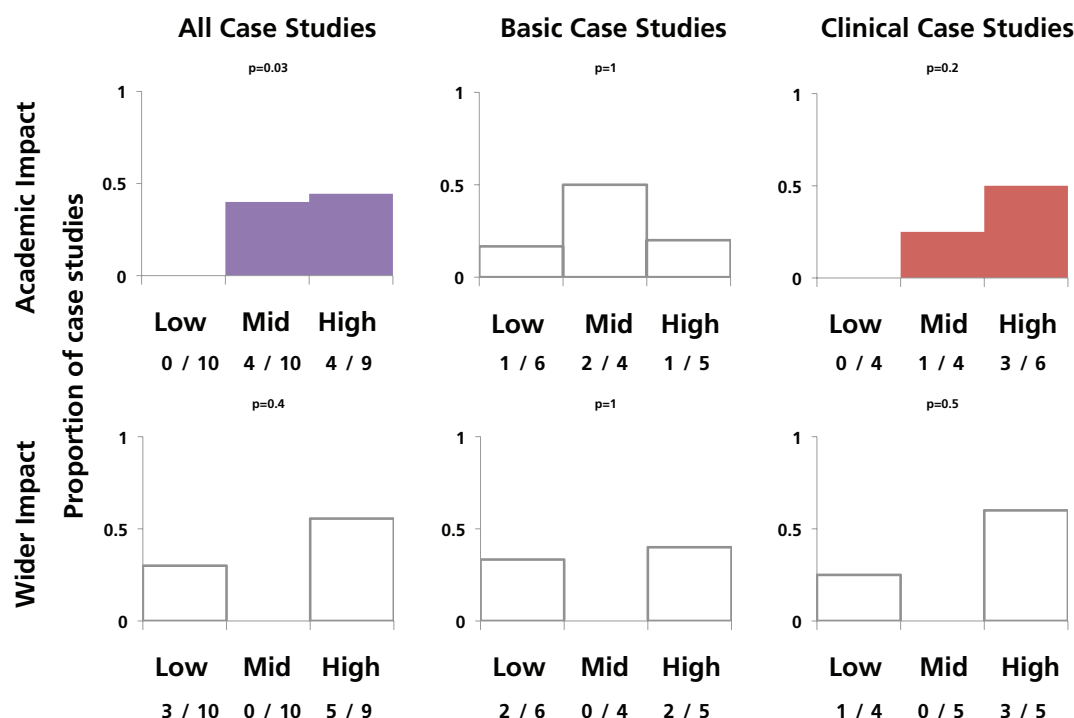
5. International collaboration is associated with high academic impact

We defined international collaboration as activities involving researchers or others based outside the country in which the research took place. We included case studies where such activities occurred or where PIs talked about their attitudes towards international collaboration. We considered two subcategories of international collaboration: where it had facilitated the research process – for example, through the modification of research protocols; and where it had facilitated impact.

Overall, international collaboration is associated with higher academic impact (Figure 4.9). Over three quarters of high academic impact case studies (7/9) were associated with international collaboration compared to 1/10 for low academic impact case studies.

International collaboration is also more strongly associated with high-impact clinical research than with basic biomedical research.

Figure 4.10
International collaboration facilitating research



5a. International collaboration facilitating research

The subcategory “international collaboration facilitating research” (Figure 4.10) shows an association with high impact that is strongest for academic impact when all case studies are considered. Examples include collaboration with international research groups that strengthen research protocols, collaborations to bring new techniques into the work and collaborations born out of a PI having a resource that is helpful to other researchers (such as a database of gene mutations). We found that this type of collaboration has a strong positive influence on academic impact for clinical research projects:

“A further factor that impinged on the design of the data collection and reporting was that a group of experts met at Utstein Abbey in Norway and produced recommendations for standardised reporting.”

“For example, all the quality control protocols and systems were international. ... This international collaboration (and the associated meetings) was confirmed by [the PI] as a key

driver in improving the science and influenced the way research was done.”

For basic biomedical research collaboration, facilitating research included mentoring and the provision of particular technical skills or reagents; there was no association with higher impact.

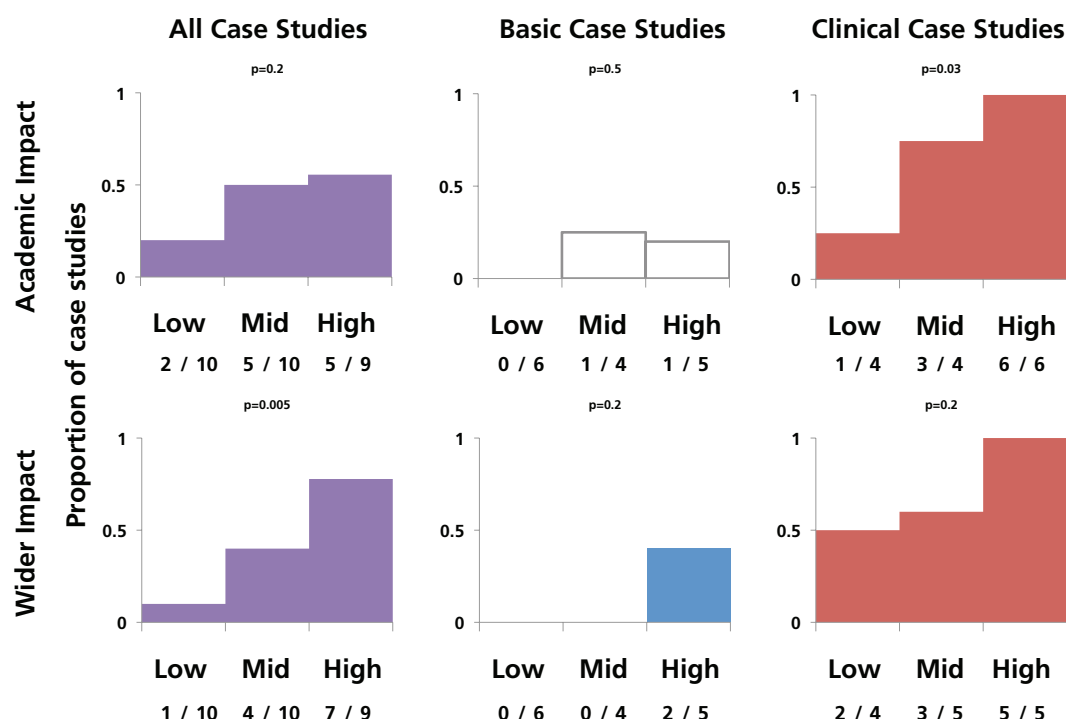
5b. International collaboration facilitating impact

The subcategory “international collaboration facilitating impact” was only identified in three case studies and showed no particular association with impact.

Overall, our analysis suggests that international collaboration is more important in carrying out research leading to impact than it is in facilitating the impact of research – possibly because much of the impact is national rather than international in nature.

Policy implication: When seeking to achieve high academic impact, encourage and support international collaboration for both basic biomedical and clinical research.

Figure 4.11
Engagement with practitioners and patients



6. Engagement with practitioners and patients is associated with high academic and wider impacts

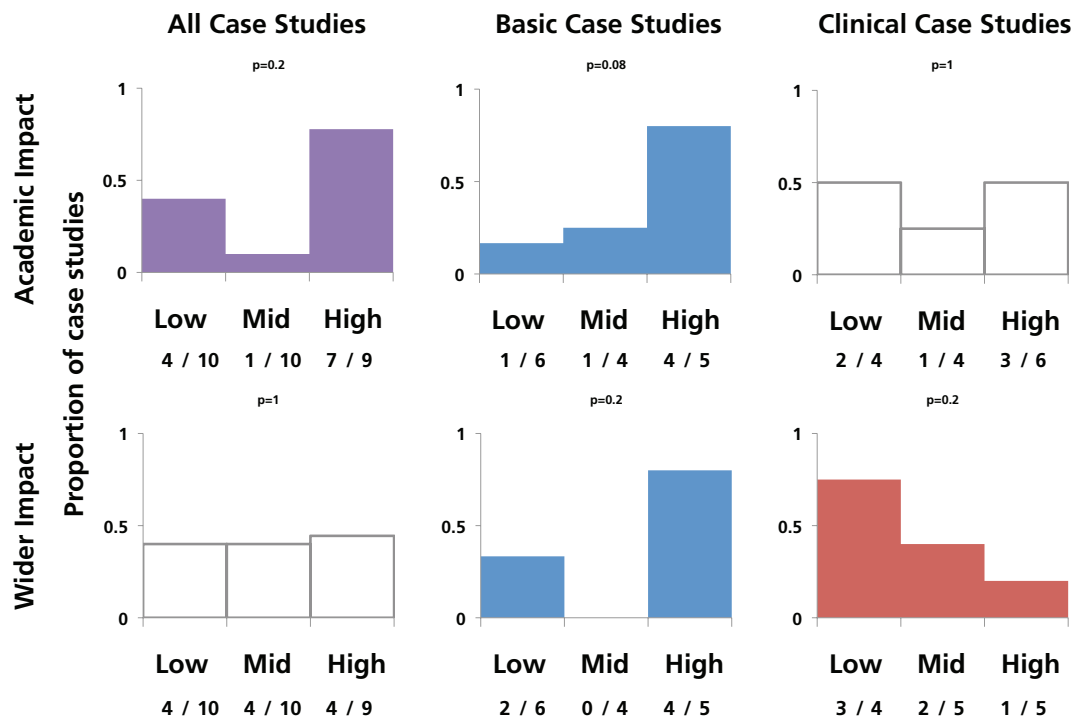
We defined engagement with practitioners and patients broadly, indicating that the PI had some interaction with either group in a way relevant to the planning or organisation of the research project, or to achieving impacts. We do not mean simply involving patients in trials or studies. It became clear that a track record of collaboration with practitioners and patients was much more a feature of clinical than of basic biomedical research. Ten out of 14 clinical case studies showed this kind of collaboration, but only 2/15 basic biomedical studies. However, there is an association between a research project's engagement with practitioners and patients and high academic and wider clinical impacts. All high academic (6/6) and wider (5/5) impact case studies on clinical research involved practitioners and patients, compared to 1/4 for low academic impact and 2/4 for low wider impact case studies. As Figure 4.11 illustrates, we found that while there were only two basic biomedical research projects where collaboration with practitioners

and patients was identified, they both achieved a high rating for wider impact for basic biomedical research, constituting 2/5 such projects. Of the six low wider impact and four mid wider impact basic biomedical case studies, none were identified as having practitioner or patient collaboration.

The associations were weaker when the alternative methods of classifying basic biomedical and clinical cases were applied: two of the clinical high impact cases fell into the basic biomedical mid-impact category.

While most of the evidence gathered about this in our case studies specifically relates to engagement after the research has been produced, there is evidence that such engagement leads more readily to publication in high-profile journals, although further work is needed to explore this. There is a clear logic underpinning the association between researchers whose clinical research has a wider impact and their engagement with practitioners and patients. But what is less clear from the figures is whether it is the engagement with practitioners and patients that helps to generate the wider impacts, or whether the wider impacts

Figure 4.12
Collaboration with industry



stimulate practitioner/patient engagement. Of course, we should remember that clinicians who carry out research are almost inevitably going to have engagement with patients and practitioners. In that regard it might be surprising that in 4/14 clinical research projects the case study did not identify any engagement with practitioners or patients. However, further analysis revealed that these four projects were all exploratory or observational studies looking for markers or associations, an approach which need not necessarily involve practitioners or patients directly.

Whatever the cause and effect, it is clear from various case studies that some researchers make considerable efforts to engage with practitioners and patients, promote the impact of their research and undertake knowledge transfer. For example:

“The more direct impacts were with the clinicians working with the researchers and the health promotion team and their work with the Hunter community and local patient and advocacy groups.”

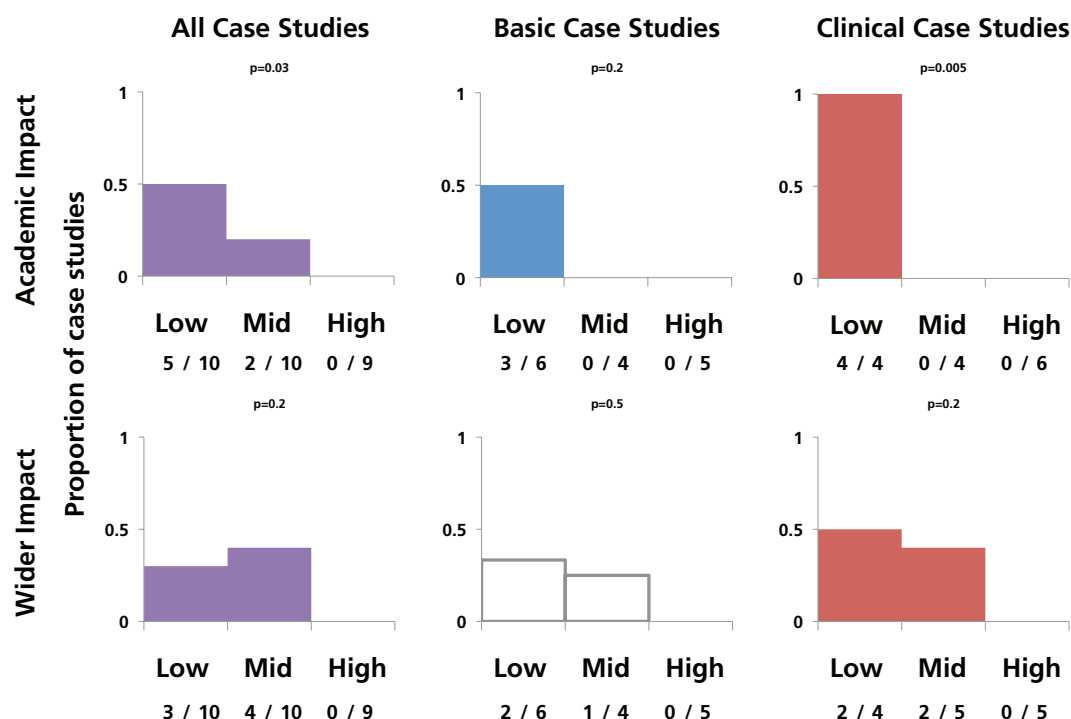
“Formal networks, such as the Canadian Stroke Network, have also been a huge help for this project in putting the team in touch with other collaborators or clinicians who have patients with high risk for heart disease or stroke.”

“As a leading clinician in this field, and Medical Advisor and Director to the UK patient and research organisations, X was well placed to provide ‘official’, research-informed advice for clinicians and patients.”

From a funding viewpoint, these findings are consistent with the claims in the literature that researchers who want their work to have some influence on policy decisions are more likely to be successful if they collaborate in some way with practitioners and patients (Innvær et al., 2002; Hanney et al., 2003; Denis and Lomas, 2003; Conklin et al., 2008).

Policy implication: When seeking to achieve high academic and wider impacts, encourage and support clinical researchers who have a record of engaging with practitioners and patients.

Figure 4.13
Negative or null findings



7. Basic biomedical research collaboration with industry is associated with high academic and wider impacts

We defined collaboration with industry as occurring whenever there was clear evidence of the PI or a key member of the team working with, or providing advice to, industry, or where an industrial company was identified as providing resources to support or facilitate the research. Four out of the five basic biomedical projects that received a high academic impact rating had evidence of collaboration with industrial partners, compared to 1/6 low-impact projects. The same number (4/5) of basic biomedical projects that were rated high for wider impacts had also collaborated with industry, compared to 2/6 for low-impact (Figure 4.12).

We believe that this relationship may be the result of the access to various additional resources that collaboration with industry has provided (see the quotes below), although it is quite possible that the association works as well in the opposite direction and that industry seeks out high-profile researchers.

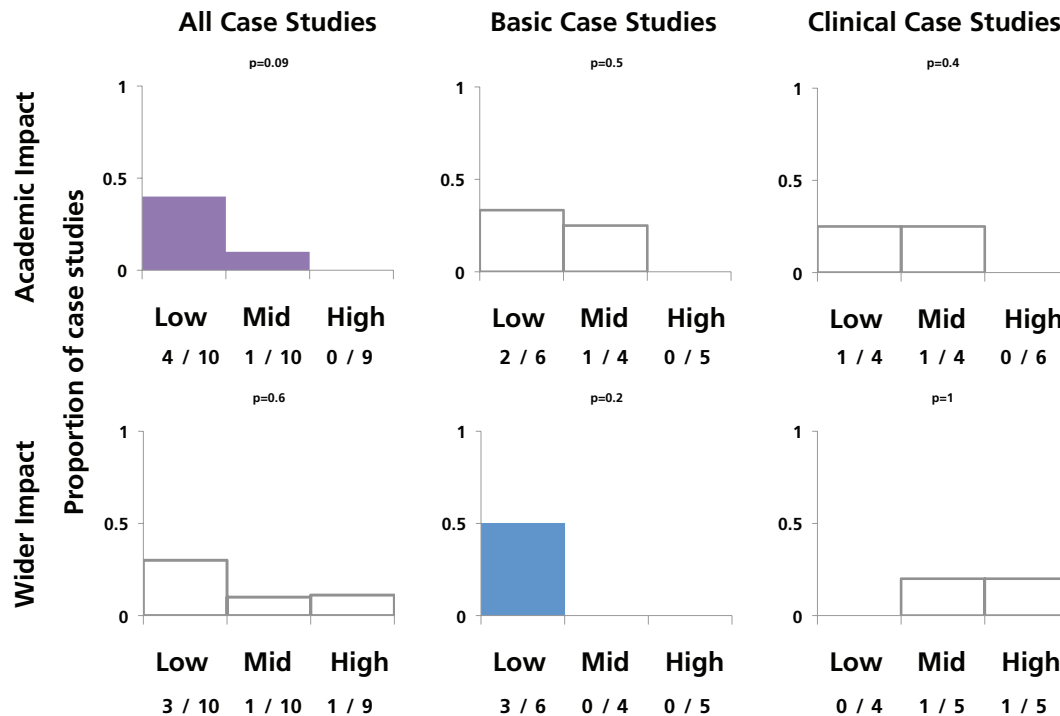
“The PI was also the recipient of large sums of funding from a variety of sources over the later years of the grant. In particular he won substantial support funding from industry in 1995.”

“The PI stated that doing research for the pharmaceutical industry often generated generous rewards and that at times he has applied surpluses from industry funding to his stroke research.”

Unlike basic biomedical research, from our study there appears to be no clear relationship between collaboration with industry and the academic impact of clinical research projects; indeed, for wider impact the relationship is negative, with more low-impact case studies involving collaboration with industry than high-impact ones. We do not fully understand this surprising association and it warrants further investigation.

Policy implication: When seeking to achieve high academic and wider impacts from basic biomedical research, encourage and support collaboration with industry.

Figure 4.14
Initial rejection of grant application



8. Negative or null findings are associated with low academic and wider impacts

We defined projects with negative or null findings as those that either failed to support a specific hypothesis formulated by the researcher (null findings), or were cut short before the planned work was complete, due to initial findings contradicting the accepted viewpoint in the field (negative findings). Seven of the 29 case studies had negative or null findings. The majority (six) of these set out to test a specific hypothesis formulated by the researcher. The one remaining case study produced initial results that contradicted the accepted viewpoint in the field, a finding that prevented some of the planned subsequent work from taking place.

A clear pattern emerging from our study is that negative or null findings in both basic biomedical and clinical research are associated with low impact (Figure 4.13): 7/29 case studies resulted in negative or null findings. These seven constituted 5/10 of the low-impact academic studies, 2/10 of the mid-impact academic studies, and none of the high-impact academic studies. Similarly the seven

constituted 3/10 with low wider impacts, 4/10 with mid wider impacts and, again, none of those with high wider impacts. This is most clearly evident in clinical research, where we noted that 4/4 case studies receiving a low academic impact rating and 2/4 cases given a low wider impact rating had all produced negative or null findings. None of the grants producing negative or null findings was considered to have had high impact, either academic or wider.

These results suggest a bias against negative or null findings, particularly in academic impact. We believe that this is most likely to be attributable to the fact that journals are often unwilling to publish papers on research that has delivered such findings (Johnson and Dickersin, 2007); similarly, researchers may be reluctant to submit these papers for publication in the first place, although we note that all our case studies produced at least one publication. It must also be hard to realise impacts for research that failed to prove something (as opposed to research that proved that something failed).

If there is such a bias, there are two risks associated with it: first, that research resources will be

wasted by others duplicating the same negative or null results; second, that clinical practice may continue with things that do not work.

Evidence from one case study suggests that, in addition to contributing little in terms of knowledge production, negative findings may also have had a negative impact in research targeting and capacity building. One PI noted that a PhD student on the grant:

“would have struggled to find a good position in academia had he wanted to stay, due to the negative findings of the project ... and through no fault and no reflection on his research quality.”

We should also be aware that there may have been some bias in our method, perhaps unavoidably so. In particular, it is easier to conceptualise and estimate impact of things that *did* happen than of things that did not.

Policy implication: Research funders should acknowledge the importance and potential significance of negative or null findings when assessing the impact of research.

9. Initial rejection of a subsequently accepted basic biomedical research grant may be associated with low academic and wider impacts

This is a novel observation that, as far as we are aware, has not been made in the literature and needs further investigation. We found that the initial rejection of a research proposal followed by its acceptance by a funding body was relatively uncommon (occurring in 5/29 cases). Of six basic biomedical studies, 3/6 with low wider impact had initially been rejected compared to 0/4 in the mid category and 0/5 with high academic impact (Figure 4.14).

Three of the five initially rejected case studies were on basic biomedical research and all three were UK cases. The remaining two projects initially rejected were clinical, one from the UK and

one from Australia. At least 3/5 initially rejected projects were revised to make them smaller, or more focused, before being re-submitted for funding and all five were re-submitted to a different funder.

“An initial application for funding, made to the Medical Research Council (MRC) was unsuccessful despite being awarded an ‘alpha’ for its scientific content. The applicants then re-formulated the proposal to make it more specific to cardiovascular disease, before submitting it to the X.”

One possible explanation may be that proposals that are initially rejected by review committees indicate a flaw or concern in the research that is carried through in a re-application and ultimately into its academic and wider impacts. What is not clear is why the subsequent acceptance of an initially rejected proposal is disproportionately prevalent in the UK.

Policy implication: Further research is needed to confirm whether initial rejection of a research proposal is associated with low impact. Until this finding can be confirmed or refuted, funders may want to carefully consider such proposals.

Concluding thought

This report identifies some key factors that appear to be related to research impact and successful translation, which were discussed above and are summarised in Table 4.5, although it is clear there is much more to be discovered. Our observations, and the policy implications that they raise, ought to make policy makers think more deeply about the research they fund and provide some evidence to improve their decision making. As we noted at the outset, this study clearly does not answer all the questions about how to fund research and we look forward to other studies that build understanding in this area.

Table 4.5
Factors associated with high- and low-impact research

Factor	Evidence	Policy implication
Basic biomedical research with a clear clinical motivation is associated with high academic and wider impacts	All high academic (5/5) and wider impact (5/5) case studies on basic biomedical research demonstrated a clinical motivation, compared to 2/6 low academic impact case studies, and 3/6 for low wider impact.	When seeking to achieve high academic and wider impacts, encourage and support clinically motivated basic biomedical research.
Co-location of basic biomedical research in a clinical setting is associated with high wider impact	The majority (4/5) of high wider impact case studies on basic biomedical research were conducted in a clinical setting, compared to 2/6 low wider impact case studies.	When seeking to achieve high wider impacts from basic biomedical research, encourage and support the co-location of basic biomedical researchers with clinicians in a clinical setting (e.g. a teaching hospital or health organisation).
Strategic thinking by clinical researchers is associated with high wider impact	All high wider impact (5/5) case studies on clinical research had evidence of strategic thinking by the PI, compared to 1/4 low wider impact case studies.	When seeking to achieve high wider impacts from clinical research, focus clinical research funding on PIs or teams who think strategically about translation into clinical practice.
Research collaboration is associated with high academic and wider impact	The majority (7/9) of high academic impact case studies involve some type of collaboration compared to 1/10 academic low-impact case studies.	When seeking to achieve high academic and wider impacts, encourage and support research collaboration for both basic biomedical and clinical research.
International collaboration is associated with high academic impact	Over three quarters of high academic impact case studies (7/9) were associated with international collaboration, compared to 1/10 low academic impact case studies.	When seeking to achieve high academic impact, encourage and support international collaboration for both basic biomedical and clinical research.
Engagement with practitioners and patients is associated with high academic and wider impacts	All high academic (6/6) and wider impact (5/5) case studies on clinical research involved practitioners and patients, compared to a quarter (1/4) for low academic impact and a half (2/4) for low wider impact case studies.	When seeking to achieve high academic and wider impacts, encourage and support clinical researchers who have a record of engaging with practitioners and patients.
Basic biomedical research collaboration with industry is associated with high academic and wider impacts	In basic biomedical research, the majority of high academic (4/5) and wider impact (4/5) case studies had evidence of collaboration with industrial partners, compared to 1/6 low academic impact and 2/6 low wider impact case studies.	When seeking to achieve high academic and wider impacts from basic biomedical research, encourage and support collaboration with industry.
Negative or null findings are associated with low academic and wider impacts	7/29 case studies resulted in negative findings. These 7 constituted 5/10 of the low-impact academic studies, 2/10 of the mid-impact academic studies, and none of the high-impact academic studies. Similarly the 7 constituted 3/10 with low wider impacts, 4/10 with mid wider impacts and, again, none of those with high wider impacts.	Research funders should acknowledge the importance and potential significance of negative or null findings when assessing the impact of research.
Initial rejection of a subsequently accepted basic biomedical research grant may be associated with low academic and wider impacts	Initial rejection of a subsequently accepted research proposal was uncommon (5/29) but associated with low wider impact for basic biomedical research. 3/6 low wider impact case studies on basic biomedical research had initially been rejected, compared to 0/5 high-impact case studies.	Further research is needed to confirm whether initial rejection of a research proposal is associated with low impact. Until this finding can be confirmed or refuted, funders may want to consider such proposals carefully.

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This report explores the impacts arising from cardiovascular and stroke research funded 15–20 years ago and attempts to draw out aspects of the research, researcher or environment that are associated with high or low impact.

The report describes a case study-based review of 29 cardiovascular and stroke research grants, funded in Australia, Canada and UK between 1989 and 1993. The case studies focused on the individual grants but considered the development of the investigators and ideas involved in the research projects from initiation to the present day. Grants were selected through a stratified random selection approach that aimed to include both high- and low-impact grants. The key messages are as follows.

- The cases reveal that a large and diverse range of impacts arose from the 29 grants studied.
- There are variations between the impacts derived from basic biomedical and clinical research.
- There is no correlation between knowledge production and wider impacts
- The majority of economic impacts identified come from a minority of projects.
- We identified factors that appear to be associated with high and low impact.

This report presents the key observations of the study and an overview of the methods involved. It has been written for funders of biomedical and health research and health services, health researchers, and policy makers in those fields. It will also be of interest to those involved in research and impact evaluation.

This product is part of the RAND Corporation monograph series. RAND monographs present major research findings that address the challenges facing public and private sectors. All RAND monographs undergo rigorous peer review to ensure high standards for research quality and objectivity.

